The Dock & Harbour Authority

No. 473. Vol. XL MARCH, 1960 Monthly 2s. 6d.

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Depth (metres)	1,50	1,50	1,80	1,80	1,80
Draft app. (metres)	0,65	0,70	0,80	0,80	0,75
Max. cutter depth (metres)	3,50	5	6	7	8
Max. distance of discharge (metres)	250	500	750	900	1000
Max. height of discharge at max. distance (metres)	3	3	3	3	3
Mixture production at max. height and distance cbm/h.	300	400	620	900	1200

STANDARD SIZES	ZC 17½	ZC 20	ZC 25	ZC 30	ZC 35
*Percentage of soil in mixture	10-20	10-20	10-20	10-20	10-20
Soil production at max. height and distance cbm/h.	30-60	40-80	62-124	90-180	120-240
Diameter suction pipe (cm.)	20	25	30	35	40
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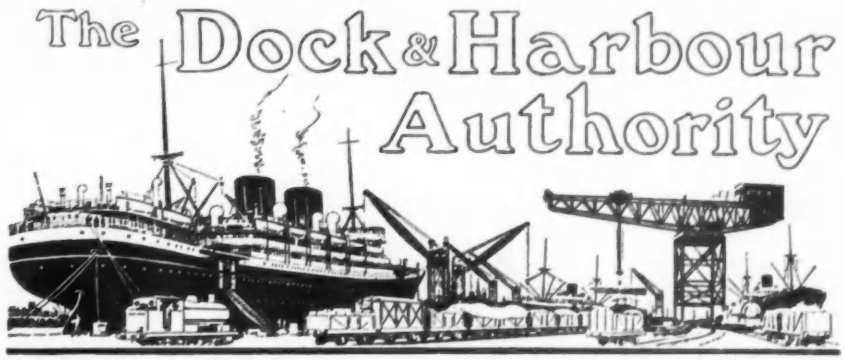

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The Dock & Harbour Authority

An International Journal with a circulation extending to 85 Maritime Countries

No. 473

Vol. XL

MARCH, 1960

Monthly 2s. 6d.

Editorial Notes

Oil Loading Terminal, Sungei Pakning

Sungei Pakning, Sumatra, the marine terminal of N.V. Caltex Pacific Maatschappij, had the distinction in October 1956 of loading the then world's largest tanker "Universe Leader" (85,500 d.w.t.) with her first cargo. She was loaded at an anchorage by a fleet of T-2 tankers conveying crude oil down the Siak River from the headworks and the same means was employed to lighten her on arrival at San Francisco before draft could be reduced sufficiently for her to proceed alongside. Since then, a new ocean terminal has been brought into use at Pakning; although designed primarily to accommodate two tankers of 50,000 d.w.t. berthed one on either side, it has been used successfully by "Universe Commander," also 85,000 d.w.t. and, by the time of writing, it may indeed have serviced "Universe Apollo," 105,000 d.w.t., the largest tanker now afloat.

The article which we publish in this issue provides an interesting description of the new loading facilities which are fed through a submarine pipeline some 1,700-ft. long. Tank storage established at the inshore end has improved the transfer from the Minas field which can now be performed more economically by river tankers and eventually the construction of a new pipeline may eliminate this long haul altogether.

Some of the problems which confront the use of super-tankers having a laden draft of 46-48-ft and beams upwards of 125-ft. are well illustrated in the article. It is true that these vessels are employed exclusively in the transport of crude oil and they can be berthed satisfactorily at island jetties which do not present many constructional difficulties in fairly sheltered waters and which can be linked to the shore by a single submarine pipeline. Not so the general-purpose tanker carrying a variety of product oil, which must be provided with a multiplicity of transfer lines to avoid down grading by contamination; but fortunately the general-purpose tanker is hardly likely to approach the super-tanker in size. Recent advances in the techniques of launching and protecting submarine pipelines have led to their increasing use in oil terminal works, particularly at loading berths usually located in unfrequented waters. The loading terminal has some advantages, too, since it need only resist the berthing impact of a vessel in ballast, at about half her maximum laden draft. In such circumstances, however, windage may become the preponderating influence.

The more general availability of octagonal box steel piles, thick-walled steel tubes for shell piles and wide-flange beams has greatly simplified the design and expedited the construction of marine structures such as the article describes, particularly as cathodic protection can now give almost complete immunity from the action of corrosive waters. In oil terminal work, especially where dangerous petroleum is handled, all-steel construction ensures proper electrical continuity (essential for the effectiveness of cathodic protection) which facilitates the countering of static electricity effects. The Institute of Petroleum Electrical Code 1950 stipulates that an electrical bond must be made between the jetty with its pipelines and oil-carrying vessels before hoses are connected, and this bond must not be broken until the hoses have been disconnected.

Provided complete cathodic protection is given, preferably by the power-impressed system (which is employed at Pakning), the economic life of such a structure, which is largely determined by obsolescence, can be fully as long as the circumstances warrant. A composite structure embodying reinforced concrete piles might indeed be less successful, for the build-up of cathodic protection products in the reinforcement may result in the cracking and spalling of the concrete.

It is observed that the designers at Pakning have not employed an insulating coating of lacquer below high water mark although its absence may involve an excess use of electrical current and apparently they prefer to rely on good surface protection in the wind/water zone rather than on the cathodic protection which is commonly believed to have an appreciable effect even between high and low water mark.

Documentation

We make no apology for returning again to the subject of "Documentation" which, judging by the correspondence received, has aroused a lively interest, and possibly some misconception, as will be observed from the further letters which appear on a following page.

The study conducted in San Francisco, which we reviewed in this Journal last December, was devoted to ship's documentation and its counterpart in civil aviation. This aspect of documentation is primarily concerned with the statutory requirements for numerical data and therefore has little effect on the scope and method of operations. Chambers of Shipping in negotiation with the respective national authorities are doubtless best fitted to represent the case for uniformity and simplification of these requirements where they can be shown to be unnecessarily exacting.

The author of a previous article dealing with the Administration of Terminal Facilities argued more cogently that a reduction in the mass of paper work at ports cannot be achieved without a radical change in the physical and administrative processes upon which it is based.

A subsequent article in our January issue on the Problem of Documentation in Ports presents yet another aspect, and the

author views the subject in the light of his wide experience in supervising the loading and unloading of cargo.

Whatever the point of view, it seems to be generally agreed that the present weight of documentation is becoming intolerable and that the solution of the difficulty lies in a methodical study of the ways of effecting a standard system which would be acceptable to all those concerned with the handling and movement of cargo.

Pallets for International Use

Palletisation is now paying dividends in many spheres. Making goods into unit loads on pallets can speed handling in factory premises, facilitate distribution, enable transport vehicles to be turned round more quickly, reduce the risk of damage, save storage space and make physical work easier. Nationally, the introduction of pallets into industry has proceeded with additional speed since the number of different sizes of pallets has been reduced by standardisation. The employment of palletisation in international traffic—and particularly in sea traffic—is a more complex operation, however, and standardisation in this sphere is equally important. In an article on page 333 of this issue, the progress of the work of the International Organisation for Standardisation, which is in course of producing an international standard for " pallets for the unit load method of materials handling " is examined in detail. As will be seen, thirty-five nations are members of the Technical Committee engaged in this work, sixteen of them (including the United Kingdom, U.S.A. and U.S.S.R.) being participating members.

Nuclear Power—and Safety

It may seem strange, on first reading, to find the Chamber of Shipping's annual report suggesting that nuclear-powered merchant ships will not be on the United Kingdom Register for a long time ahead, and at the same time devoting a good deal of space to the problems arising from the carriage of radioactive materials and the possibility of nuclear casualties. But the nuclear ship *is* with us—the American submarine *Savannah* will literally be with us either this year or next and the Russian ice-breaker *Lenin* has had her sea trials—radioactive material *is* being carried by sea, and the possibility of casualities cannot be ruled out. And the casualties might not happen only at sea; they could, conceivably, occur when a nuclear ship was in port.

It is here that the interest of dock and harbour authorities arises. A perusal of the report will show that the most careful consideration is being given, nationally and internationally, to the important issues involved. No British shipowner is likely to commission a nuclear-powered ship unless and until he is completely satisfied that the safety factor is as high as may reasonably be expected. The Government, too, will be equally insistent upon the maximum standards being achieved and the recent report of the committee on safety of nuclear ships (on which British shipowners were represented) deals with all aspects of the construction and operation of such ships.

If ever there was a case for international co-operation this is one. The liability of owners of nuclear ships for damage caused by them was outside the terms of reference of the safety committee. Shipowners in this country discussed the matter with the Ministry of Transport and the resulting views were put before a sub-committee of the Comité Maritime International. This sub-committee drafted a convention which was submitted to a plenary conference of the C.M.I. held at Rijeka, in Yugoslavia, and seventeen of the twenty countries represented there voted for it. The draft convention will now come before a Diplomatic Conference to be held in Brussels in the Spring.

Other parts of the Chamber's report affect in greater or lesser degree the responsibilities of those in charge of this country's dock and harbour systems. Tonnage measurement, for example, now the province of the Inter-governmental Maritime Consultative Organisation, has been dealt with by a special sub-committee, reconstituted for the purpose of carrying out detailed consultation with the Ministry of Transport and with shipowners. The result of all this preliminary work has been that virtual unanimity has been established and a basis agreed on the submissions to be made by United Kingdom delegates when they attend I.M.C.O.

Technical Possibilities of a Thames Flood Barrier

Readers of this Journal will recall that, as a result of the unprecedented East Coast storm of 31st January, 1953, a departmental committee under the chairmanship of the late Viscount Waverley was appointed in the following April to examine the cause of the floods, the possibility of their recurrence, and the reasonable margin of safety required in sea defences. The Committee, whose report was published in May 1954, were impressed by the possibility that serious flooding might occur in the London area if the 1953 water levels were ever exceeded and recommended a detailed study of the technical and engineering aspects of two suggestions: first, that existing defences all along the river should be raised, and second, the spanning of the river with a movable barrier which would, except in times of threatened surges, leave the waterway free for shipping.

Following the Waverley Committee's recommendations, a technical panel was set up, drawn from the staffs of Government departments, local authorities and other bodies mainly concerned. They were asked to survey existing flood defences of the Thames and estimate the cost of raising them, and to advise whether a movable barrier across the river merited further investigation. The panel concluded that the cost of raising existing defences by three feet between Teddington and Long Reach might approximate to the cost of constructing a movable barrier in Long Reach. They thought that such a barrier was likely to be practicable and that the problems of the siting, design and construction, and the question of cost, should be referred to a firm of consulting engineers.

A White Paper (Technical Possibilites of a Thames Flood Barrier—Cmd. 956, H.M.S.O. price 3/6) on the feasibility of this proposal has now been presented to Parliament. In this, the conclusions and recommendations of Messrs. Rendel, Palmer and Tritton and Messrs. Sir Bruce White, Wolfe Barry and Partners, the two firms of consulting engineers appointed by the Minister in July 1956, indicate that the construction of a movable barrier in Long Reach would be technically feasible. It would, however, have a limited purpose; namely, the exclusion from the heavily built-up area of dangerous surges travelling up the estuary from the North Sea. Only when such a surge was threatened would the barrier be closed. It would not eliminate all risk of flooding in the area below Teddington Weir and it would not have any effect in any circumstances on conditions above the weir. In particular, it would not have the purpose of preventing floods which might be caused by heavy rainfall or melting snow.

Many problems remain to be solved, and there must be further study before any final decisions can be taken whether or not to carry out works which would be both extensive and costly. There are, for example, navigational and other problems inherent in the provision and operation of a barrier which need further exploration in the interests of the large volume of shipping which would have to pass through it.

The Government now proposes to consult the local authorities, river boards, conservancies and other bodies concerned in the Thames estuary both above and below Long Reach. These consultations will cover all aspects of flood prevention in the estuary, including the barrier proposal and the arrangements under which (if it goes forward) such a barrier might be built, maintained, operated and paid for.

Oil Loading Terminal for Pakning, Sumatra

Construction of Off-Shore Mooring Structure

By BARNETT SILVESTON, M.A.S.C.E.
(Partner, Tippetts-Abbett-McCarthy-Stratton,
Consulting Engineers, New York.)

THE years since World War II have been witness to a most remarkable increase in the size of ocean-going petroleum tankers. Tankers have evolved from the T-2's of 16,700 d.w.t. carrying capacity with length of about 524-ft. and full draft of about 30-ft., to giants, some of which are already in operation, of 85,000 and 100,000 d.w.t. with lengths up to 950-ft. and drafts of 48-ft. Indeed, tankers of 45,000 d.w.t. capacity are now comparatively common.

The advent of these large carriers has given rise to the problem of providing adequate docking facilities at marine terminals. Few harbours in the world have sufficient depths of water alongside shore terminals for the largest vessels. Since the cost of dredging to provide deep water is often prohibitive, it is sometimes necessary to resort to unconventional methods of providing the necessary facilities. Thus, offshore mooring structures in deep water served by submarine pipelines from shore offer a solution to the problem. One such terminal is that constructed for N. V. Caltex Pacific Petroleum Mij. in Sumatra.

This article describes the construction of the wharf and pipeline, including the energy-absorbing fender system and means employed to protect steel in the structure against corrosion.

History of Pakning Terminal

N. V. Caltex Pacific Petroleum Mij. exports crude petroleum from the Minas oil fields in Central Sumatra, Indonesia. Petroleum is transported from the oil fields by river tankers down the Siak River to Pakning on the east coast of Sumatra. At Pakning, the oil is stored in tanks from which it is loaded into ocean-going tankers for transport to the United States.

In 1953, a wharf was constructed at Pakning to accommodate tankers of 28,000 d.w.t. In 1955, as part of a major expansion programme, N. V. Caltex Pacific Petroleum Mij. decided to provide a second wharf capable of accommodating the large tankers being planned at that time. This wharf was completed in March, 1957 and, although designed for 50,000 d.w.t. tankers, tankers of 85,500 d.w.t. have been successfully loaded there.

General Description

The new wharf is located about 1,800 feet offshore in about 60-ft. of water and is oriented parallel to the thread of the current. The range of spring tides is about 10-ft. and tidal currents frequently run at 3.5 knots. The wharf is designed to accommodate two 50,000 d.w.t. tankers simultaneously, one berth being provided at each side of the wharf. A 22-in. diameter submarine pipeline connects the wharf with shore installations.

The wharf consists of a central loading platform 180-ft. long and 40-ft. wide, flanked on each side by two mooring dolphins (See Fig. 1). The two intermediate dolphins are connected to the central platform with walkway bridges 104-ft. long. The end mooring dolphins are isolated structures, launches being used to handle ships' bow and stern lines at these points.

The central platform and the dolphins are timber decked steel structures supported on steel pipe piles. Energy-absorbing fender panels are installed on the central platform and the intermediate mooring dolphins.

Wharf Foundations

The river bottom at the wharf site consists of several feet of loose sand overlying a thick stratum of clay, which is soft near the surface but becomes firm with increasing depth. The maximum pile design loads were 70 tons in compression and 55 tons in tension. To mobilise adequate frictional capacity in the clay, vertical piles were to be 140-ft. long and batter piles 150-ft. Steel pipe piles of 20-in. diameter and $\frac{1}{2}$-in. wall thickness with closed ends were selected as the most suitable type of pile.

Steel pipe in lengths of 40-ft with edges bevelled for welding was purchased in Germany and delivered to fabricating shops in Singapore. The finished piles were then transported by barge across the Strait of Malacca to Pakning, a distance of about 250 miles.

In order to pitch each pile, holes were drilled near the closed end, allowing the tip to sink. The head of the pile was lifted by a floating crane and set in the leads of a floating pile-driving

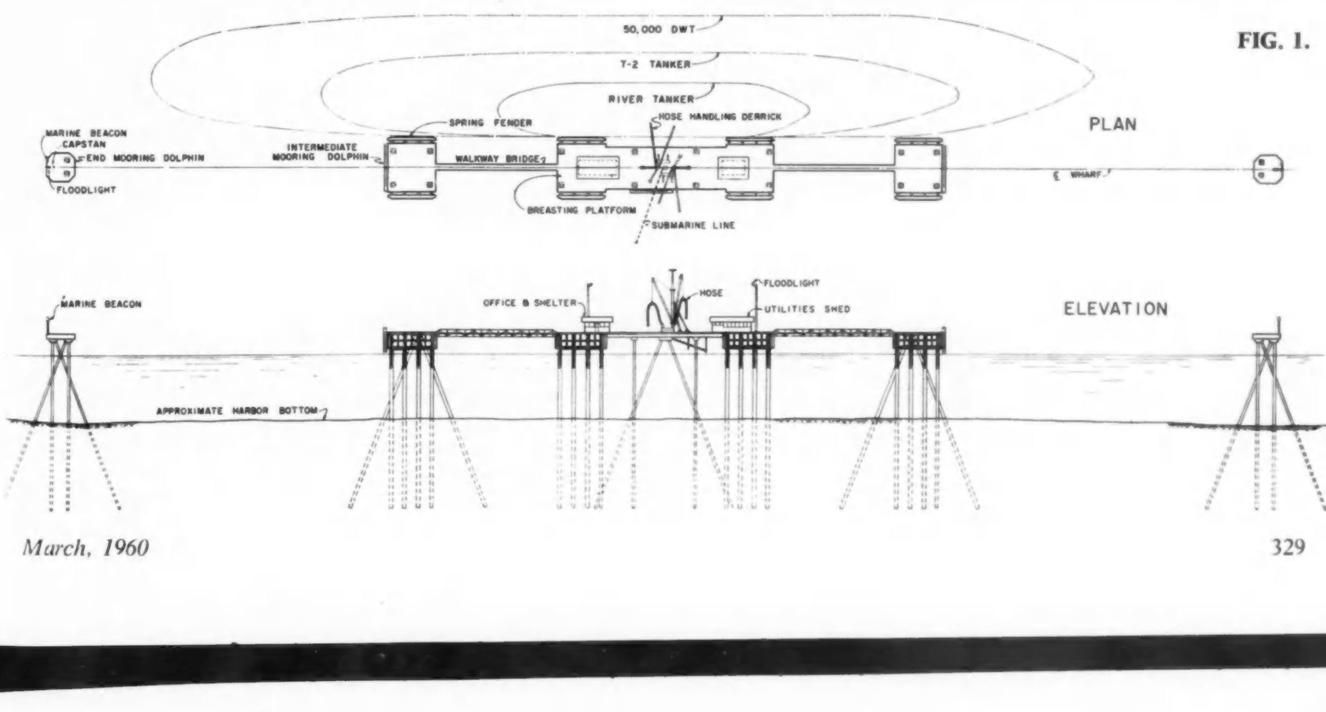
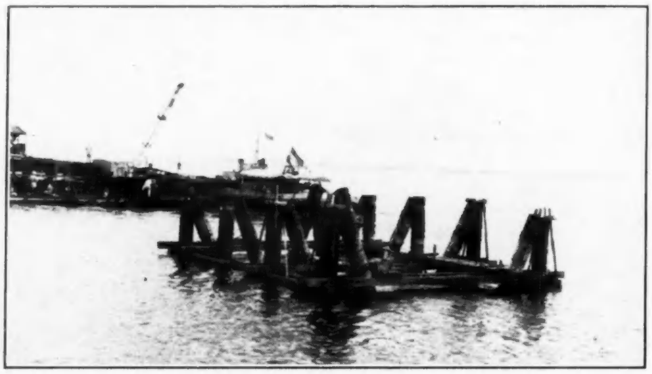


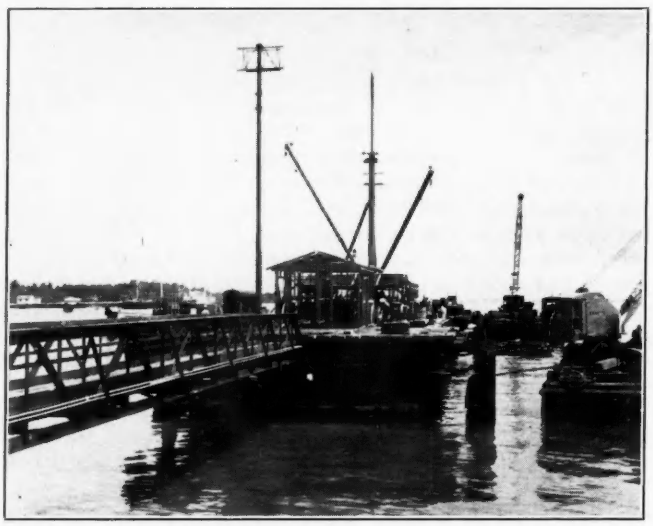
FIG. 1.

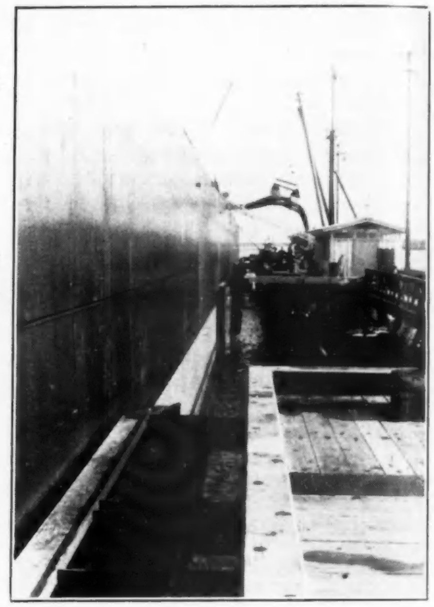
rig. The pile was held in position against currents by a guy line, attached near the tip of the pile. The guy line was removed immediately before driving. Piles were driven by a 15,000-ft/lb. single acting steam hammer.

To prevent excessive deflection and damage to the piles from tidal currents during construction, the engineers prepared a sequence of construction that would achieve stability of various structures as the work progressed.

Construction of the breasting platform began with driving the central cluster of four batter piles. These piles were lashed together and tied to an anchored barge. The pairs of batter piles on each side of the structure were next driven, lashed together and tied to the central cluster by means of temporary bracing above low water level. The bracing provided a working platform for preparation of the pile heads. The piles were cut off to the correct elevation and slots were cut to receive the gusset plates connecting adjacent piles. Plate collars were slipped over the pile tops and fastened temporarily below the slots. Gusset plates were then inserted into the slots and welded, after which the collars were raised to fit against the gussets and tack-welded. Stiffeners were also tack-welded to piles and collars. The cap beam, consisting of a 36 WF 150 section, was then tack-welded to the piles and the entire assembly finally welded.







(Left) View of Intermediate Mooring Dolphin.

(Right) Intermediate Mooring Dolphin (in foreground) and Breasting Platform (in background).

(Bottom Left) Breasting Platform and Bridge to Intermediate Mooring Dolphin.

While work progressed on the centre bent, pile driving continued on the adjacent bents. After driving, the pile groups in the adjacent bents were tied to the centre bent by temporary members. Pile tops were slotted and capped and longitudinal bracing welded into place.

With the completion of the two pile bents braced together, stability was achieved, and the barge was removed as lateral support. Construction of the remainder of the platform continued in both directions outward of the central bents.

The sequence of erection of the two intermediate mooring dolphins proceeded in similar manner.

The end mooring dolphins consisted of four pile clusters of three batter piles per cluster. Each cluster was driven as a unit and lashed together, after which the clusters were connected to obtain stability. Low water bracing again was employed to support the scaffolding for capping of the pile groups.

Submarine Pipeline

Prior to the contruction of the wharf, a 22-in. coated submarine pipeline was laid to connect the shore facilities to the island berth. The pipe was supplied with a $\frac{3}{8}$-in. Somastic coal-tar enamel coating for protection against corrosion and a $1\frac{7}{8}$-in. Heavycote concrete coating to protect the enamel coating against abrasion during and after placing and to overcome buoyancy of the line. The installation of the line involved hazards not commonly met in such an operation because of the strong tidal currents and the steep "drop-off" on the bottom profile located about 500-ft. offshore. The line was assembled to full length on the shore in a shallow trench which was flooded after the line was completed and tested. The floating pipeline, 1,700-ft. long, was towed into position by means of a winch-mounted barge firmly anchored in position and by a tug.

A pulling sled at the outshore end of the line consisted of a 14-ft. length of 20-in. piping equipped with a blind flange and lug fastened to a 10-ft. by 6-ft. steel plate sled which was streamlined to minimise drag during pulling. The sled also acts as a spread footing to restrict settlement of the pipeline into the river bottom. The shoreward end of the pipeline was laid in a gradually sloping trench to overcome the sharp "drop-off" occasioned by an underwater ledge. A minimum of 18 inches of cover was provided along the shore end to protect the pipe from breakers and scour.

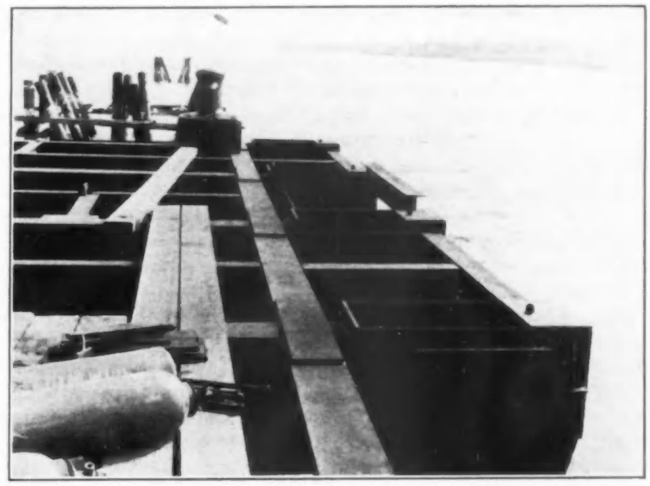
The submarine line is connected to a 20-in. riser located slightly off centre of the breasting platform. The riser pipe is supported by a pipe collar bearing on the wharf deck and is braced by several underwater struts to prevent the riser from vibrating in the current. The underwater bracing was designed

for installation without the use of divers. The pipe riser is electrically isolated from the wharf proper by means of micarta insulation. The underwater connection of the riser to the submarine line was simplified by using lap joint flanges at both ends of the riser pipe, which coupled with the flexibility at the free end of the riser made alignment of the pipe sections relatively simple.

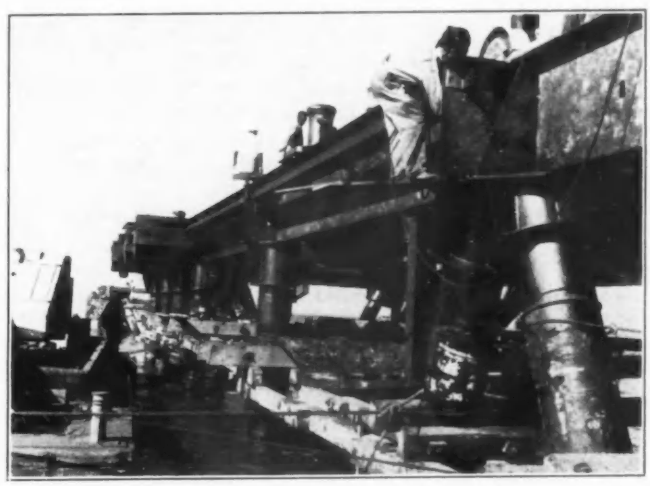
Resilient Fenders

The breasting platform and intermediate mooring dolphins are equipped with a resilient fender system designed to decelerate a vessel's approach gradually and avoid injury to the vessel and wharf that could otherwise result from the large impact forces that occur during docking of vessels. The fenders are designed to accommodate a 50,000 d.w.t. tanker berthing with a velocity component of 16-ft. per minute normal to the wharf at the instant of impact.

(Left) View of End Mooring Dolphin.



(Right) The Breasting Platform showing the Fender System and Spring Boxes.



(Bottom right) The Breasting Platform.

Four 40 ton steel springs were installed with each fender panel, each spring assembly consisting of three concentrically-mounted, helical, steel spring coils which can be compressed a maximum of 13-in. The panels are constructed of steel H-piles interconnected by steel wales and struts, and are faced with hardwood rubbing strips.

Marine borers, destructive to timber, abound in Sumatran waters, and the high humidity of the area is conducive to atmospheric rot. Hardwood were, therefore, required to resist marine borer attack and to provide resistance to decay and mechanical abrasion. White Oak and Douglas Fir had been used on Wharf No. 1 and had exhibited poor resistive qualities. The Oak suffered severely from borer attack below mean tide level and required replacement within several years of its installation. The Fir, used in untreated form for deck planking, also was short-lived because of its susceptibility to atmospheric rot.

Balau, a dense Malayan timber, obtainable in Singapore, was selected for the fender strips because it could be used to resist marine borers without creosoting. Kempas, a tough local hardwood, was picked for the decking, but to improve its useful life a preservative treatment was used. Since pressure-treating facilities were not available locally, Kempas had to be purchased in Singapore, where it was impregnated with Tanalith.

Corrosion Protection

Water temperature, salinity, and high humidity in the atmosphere all contribute to a high rate of corrosion of steel in Sumatra. Various means were considered by the engineers to protect the steel members from corrosion. These included the use of vinyl paints, bituminous coatings, gunite (sprayed concrete), metalising, Monel metal sheathing, special alloy steels (rust inhibiting), and cathodic protection. Each of the zones of varying corrosion required its own special treatment dictated by economy, accessibility, life exceptancy of the protection to be furnished, ease of maintenance, and skill required for installation. As a result of these studies and the experience gained during the construction and maintenance of Wharf No. 1, the following protective procedures were established:

(1) For the atmospheric zone, exposed metal was coated with pigmented, rust-inhibitive paints, while steel decking, cap beams and the like were given a two-coat application of Bitumastic 50 with a finish coat of Bituplastic 28 to prevent "alligatoring".

(2) In the splash zone from Elevation +2 to about Elevation +13, the pipe piles were coated with three coats of hot applied Bitumastic Enamel 70B, reinforced with two layers of Fibreglass matting. A vinyl paint system consisting of five coats of Nukemite was used on the fender panels because of the difficulty in applying the reinforced, hot enamel to WF sections.

(3) The submerged steel is not provided with any protective coating but a cathodic protection system is provided to counteract any corrosion of the steel submerged in water and mud.

The cathodic protection for the wharf consists of an impressed voltage system using Duriron anodes suspended beneath the wharf structure. The water at the site consists of ocean water diluted by the fresh waters from Siak River and has a pH value of 8.00 and a chloride content of 15,930 parts per million. A cathodic protection current of five milliamperes per square foot of pile surface submerged in water has been provided, which offers a margin of safety over the three milliamps per square foot which is frequently used for protecting structures in sea water. This safety factor takes into consideration any inequalities in current distribution caused by proximity and interference effects from the somewhat restricted anode locations.

The use of an impressed voltage form of cathodic protection was selected over a sacrificial anode type system which requires frequent replacement and consequent high maintenance costs. Various types of anode materials were considered, including scrap iron, graphite and Duriron. Although Duriron costs more than the other materials, it possesses definite advantages over graphite with regard to electrical connection detail and electrical characteristics.

Remote anode beds as well as anodes within the confines of the berth were considered. The nature of the bottom, which consists of a thin sand stratum overlying a thick layer of clay, is such that the anodes lying on the bottom would sink into the clay with deleterious effects. These effects include accelerated attack on the anodes plus possible gas blocking and increased anode voltage drop as the anodes become embedded. Suspended anodes beneath the wharf structure overcome these difficulties and were, therefore, used. Due to the ebb and flow tidal currents, the suspended anodes, if hung freely from the wharf, would have excessive movement. The wake of ships' propellers would also violently disturb the anodes. The anodes were, therefore, secured both top and bottom by means of Saran rope to prevent movement and accidental contact with the steel structure. Saran, a plastic material, was selected because of its strength and resistance to salt water action and marine borers.

The somastic coated submarine pipeline is equipped with insulating flanges at both the wharf end and the shore end of the pipe. At the present time, however, the insulating flanges at the wharf end are shunted to permit protection of the submarine line by the wharf cathodic protection system. As time passes and the mastic coating on the pipeline deteriorates, the electric load impressed on the wharf system will increase. If this load becomes excessive, an additional rectifier will be provided at the provided at the shore end and connected to a future anode bed also located at the shore end to provide a separate cathodic protection system for the submarine line.

Wharf Equipment

The wharf is equipped with two stiff-legged derricks for hose handling. Each derrick has two 40-ft. booms with a capacity of 5,000 lbs. per boom. The piping arrangement consists of a manifold with 12-in. flanges for attachment of two 12-in. rubber hoses at each berth. For catchment of oil dripping and spillage, a slop system supported under the deck has been provided.

Fire protection is afforded by two pumps; a motor-driven pump of 250 g.p.m. capacity for continuous operation during loading, and a diesel engine driven pump of 500 g.p.m. capacity for emergency use.

Electric power is supplied from shore. A submarine cable serves to transmit 4,160 volts to the wharf. There the voltage is stepped down to 480 volts for power and to 120/240 volts for lighting.

Contracts and Cost of Construction

The wharf structures were constructed by J. C. Gammon (Malaya) Ltd. The submarine pipeline was assembled and laid by Caltex engineers and local labour employed in the oil fields.

The total cost of the project was approximately $1,700,000.

Acknowledgments

Designs and completely detailed working drawings were prepared by Tippetts-Abbett-McCarthy-Stratton under direct supervision of the author.

For Caltex, the work was directed in New York by Mr. F. W. Dittus, Vice President, Caltex Service Company, and Mr. R. A. Andresen, Chief Engineer, Construction Engineering and Maintenance, American Overseas Petroleum Ltd. Mr. E. Nelson was project manager in Sumatra.

International Pallets

Review of Present Stage of Progress

By E. S. TOOTH

Serious work in the sphere of pallet standardisation began some ten years ago. In the national sphere, this matter is of most concern to manufacturers and to internal transport organisations—particularly road and rail; in the international, it has wider implications. Since it is obviously desirable that national and international standards shall be in accord, it is pleasing to see that this state of affairs is being reached with some speed.

When the appropriate organisations in many countries first considered pallet standardisation, there were already certainly scores and, probably, hundreds of different sizes of pallets in use. It is a comment on the tenacity with which this task has been tackled that the number of sizes has been reduced dramatically. Most of the first national standardising documents included only a few plan sizes. The first British standard (BS. 2629), which was published in 1955, included six. A revised British standard, to be published shortly, will include only five.

One complicating factor has been that national work can proceed faster than international, not only because it can be done more conveniently, but also because it is less complex. Thus national standards were settled in many countries before international decisions were made. This, of course, was the wrong way round, for one important purpose of formulating an international standard is to guide national standardising organisations. This, in fact, is what is now happening—somewhat belatedly, it is true. Nations, in course of producing new standards or of revising old ones, are taking account of international decisions; thus, work done at international level has far-reaching effects. This being so, it will be interesting to examine how far it has advanced.

A pallet standard deals with aspects other than dimensional. The British standard, for example, has separate sections headed (1) scope, (2) definitions, (3) dimensions, (4) designation, (5) rating, (6) testing and (7) marking. It also contains a fourteen-page appendix of explanatory notes and drawings. The international document will be at least as comprehensive but, before considering the progress made so far, it will be useful to examine the procedure which has to be followed to arrive at an international standard.

The body undertaking the work is, of course, the International Organisation for Standardisation (ISO). The object of the Organisation is "to promote the development of standards in the world, with a view to facilitating international exchange of goods and services and to developing mutual co-operation in the sphere of intellectual, scientific, technological and economic

activity". Among the means to these ends are included (a) "taking action to facilitate co-ordination and unification of national standards and issuing the necessary recommendations to Member Bodies for this purpose"; (b) "setting up international standards—provided in each case no Member Body dissents" and (c) "encouraging and facilitating, as action demands, the development of new standards having common requirements for use in the national or international sphere".

The general secretariat of ISO has, among its other duties, to keep all Member Bodies, as well as the Council, informed of the work carried out by technical committees and to keep the technical committees informed of the work undertaken by other international organisations concerned with related questions. An ISO technical committee is composed of a delegation from each of the Member Bodies (nations) wishing to take part in the work. Each technical committee has a secretariat, which is undertaken by a Member Body designated by the Council. In its capacity as secretariat, this Body acts impartially. It has its own delegation with exactly the same status as other participating members of the technical committee. It is responsible for the satisfactory conduct of the work of the technical committee and has to report annually to the Council on the results achieved. The ISO committee dealing with standardising of pallets is Technical Committee 51 " Pallets for the Unit Load Method of Materials Handling ". National delegations to this committee usually include representatives of pallet users, pallet manufacturers, transport organisations and the national standard organisation.

When a technical committee has reached agreement on a Draft Recommendation for some given question, the secretariat submits the draft to all Member Bodies and then to the Council in Geneva. Finally, it undertakes to print and publish all the recommendations or standards adopted by ISO. These recommendations or standards—the distinction will be explained later —are then placed on sale by the Member Bodies.

The secretariat of TC51 is held by the United Kingdom. The present membership of the committee is:— Participating members (16): Australia, Austria, Belgium, Czechoslovakia, Denmark, Finland, France Germany, Netherlands, Norway, Poland, Sweden, Switzerland, United Kingdom, U.S.A., U.S.S.R. Observer members (19): Bulgaria, Chile, Egypt, Greece, Hungary, India, Ireland, Israel, Italy, Japan, Mexico, New Zealand, Pakistan, Portugal, Rumania, Spain, Turkey, Union of South Africa, Yugoslavia—and it is important to remember that after each aspect of standardisation has been hammered out by the technical committee, it forms a part or the whole of a Draft Recommendation which cannot become an ISO Recommendation until approved by 60% of the Member Bodies who cast their votes after the draft has been circulated (Stage 1). A Draft Recommendation so approved becomes an ISO Recommendation as soon as it has been accepted by the Council (Stage 2). The Council then decides whether the Recommendation shall be re-submitted to ISO Member Bodies with a view to its adoption as an ISO standard. If no Member Body opposes the proposal to transform an ISO recommendation into an ISO standard, that Recommendation becomes an ISO standard (Stage 3).

Technical Committee 51 was set up in 1948 but in 1952 the Secretariat was handed over to the United Kingdom. To date, it has produced 32 resolutions, the first 24 of which form the basis of a Draft Recommendation which has been submitted to Member Bodies for approval (Stage 1 above). The contents of this document are already known, not only to national standardising committees, but to important pallet users, manufacturers and land and water transport organisations throughout the world.

As far as pallet dimensions are concerned, the document states that the nominal sizes of flat pallets for general purposes shall be (1) 32-in. x 48-in. (800-mm. x 1,200-mm.); (2) 40-in. x 48-in. (1,000-mm. x 1,200-mm.) and (3) 32-in. x 40-in. (800-mm. x 1,000-mm.). The standard will state the tolerances which shall apply to these dimensions—tolerances to be regarded as extreme limits within which each Member Body will fix its own manufacturing tolerances.

Other stipulations are that these pallets shall be double-decked and so constructed as to permit the entry of forks or fingers of lifting trucks, preferably from any side, but at least from two opposite sides; that the distance from the underside of the top deck to the ground shall be 5-in. (127-mm.) maximum, and that the free height for the entry of forks or fingers shall be $3\frac{7}{8}$-in. (99-mm.).

Further, standard two-way entry and four-way entry pallets must be constructed so that the minimum openings in the bottom decks—these are provided to allow the wheels of a pallet truck to bear upon the ground—shall conform to those indicated in drawings which will form part of the document; the bearing surface of the element or elements of the bottom deck shall be equal to or greater than 40% of the overall surface of the top deck, and if pallets of any of the above-mentioned sizes are constructed with wings for lifting, the width of the wings shall be $2\frac{1}{2}$-in. (65-mm.) minimum.

Finally, chamfering. The top edge of each member of the bottom deck of a pallet shall be chamfered on each side of the top face. The purpose of this chamfering is to facilitate the entry of the wheels of a pallet truck and it must be done in the following way:— (i) the angle between the chamfered surface and the horizontal shall be $40° \pm 5°$; (ii) the height of the vertical face of the member shall be $\frac{1}{2}$-in. $\pm \frac{1}{8}$-in (10-mm. $\pm$ 5/0-mm.). It will probably be stipulated that this recommendation shall apply to a pallet made of any material when the thickness of the member exceeds $\frac{3}{8}$-in. (10-mm.).

This, then, is a summary of the committee's decisions, which form the basis of a document now likely to be acceptable as an ISO Recommendation—and ultimately, it is hoped, as an international standard—and it is interesting to note that the nominal plan sizes mentioned in the document are three of the five sizes which are almost certain to appear in the revised British standard. Further, most of the other dimensions stated in inches also correspond exactly with those likely to be printed in the new British document. As already stated, however, this Draft Recommendation is based on only a portion of the committee's decisions and represents, in the main, the work completed by the Technical Committee by 1958. Since then, other resolutions have been passed and these will be incorporated in a further Draft Recommendation, which, complete, will in its turn be submitted to all Member Bodies for approval before receiving the blessing of the Council. These resolutions deal with box pallets, large flat pallets and a glossary of terms relating to pallets.

The present intention is to standardise two sizes of box pallets —viz. 32-in. x 48-in. (800-mm. x 1,000-mm.) and 40-in. x 48-in. (1,000-mm. x 1,200-mm.)—two of the three sizes of standard flat pallets. In general terms, the construction of the pallet itself must be similar to that laid down for flat pallets of the same plan sizes, but there are supplementary clauses dealing with (a) maximum overall dimensions, particularly of pallets with feet and (b) an international requirement of particular interest to the railways, that the design shall permit either another similar box pallet or a standard flat pallet of the same dimensions to be stacked on top of it.

The reasons for the decision to standardise two sizes of large pallets lie mainly in the sphere of sea transport. It is hoped that in due course pallets of dimensions 48-in. x 64-in. (1,200-mm. x 1,600-mm.) and 48-in. x 72-in. (1,200-mm. x 1,800-mm.) will better serve the needs of ships and, in particular, give a more economic lift for ships' handling gear and shore cranes. Many of the con-

structional details of these pallets are the same as those for the small standard sizes, but among the differences tentatively agreed are (i) that the centre bearer must not have a greater width than 7-in.; (ii) that the distance from the underside of the top deck to the ground shall be 5½-in. (instead of 5-in.); (iii) that the pallet shall have wings for lifting and that the width of these wings shall be 3-in. minimum and (iv) that non-expendable pallets of the two large sizes shall be capable, throughout their working life, of supporting a uniformly distributed load of 2,000 kg. whilst being handled and of 8,000 kg. when stacked.

The glossary of terms relating to pallets will consist of some two dozen definitions, each being illustrated. These definitions will be printed in the three official languages of ISO—English, French and Russian—and also in German. The glossary is intended for the widest possible use and its existence, even in draft form, has already eased the work, not only of the ISO committee but also of other international bodies concerned with the use of pallets in industry, including the organisation of pallet pools. Among these bodies are the International Chamber of Commerce, the Economic Commission for Europe, the Food and Agriculture Organisation of the United Nations, the International Union of Railways, the International Container Bureau, the International Labour Organisation and the International Cargo Handling Co-ordination Association. Most of these send representatives to plenary meetings of ISO/TC/51.

Of outstanding tasks, the most important is that concerned with the testing of pallets. Preliminary work on this subject has been delegated to two Working Groups, one of which is dealing with timber pallets, the other with metal pallets. Each Working Group consists of representatives of about ten nations and its duty is to produce a suitable document for consideration at the next plenary meeting of the Committee. One document will embody proposals for a basic specification and testing procedure for ISO standard flat timber pallets; the other, a testing procedure for ISO metal pallets. The specification for timber pallets will be of considerable importance and is likely to include clauses on the selection of timber, slope of grain, knots, decay, moisture content, cracks, pockets of resin and so on and also upon means of securing components.

As far as metal pallets are concerned, the present suggestion is that there shall be test methods for (a) lifting and moving and (b) stacking for each of the two categories, viz. (i) flat pallets and (ii) box pallets and post pallets. Embodied in that suggestion is the proposal to make stringent tests with a 25% overload for flat pallets and 50% for box and post pallets. Tests on flat metal pallets are likely to be for top deck and bottom deck separately; those for box and post pallets will probably include a slinging test, using eyes on the top of the superstructure.

Testing procedure for timber pallets will probably also state in specific terms how each test will be made and what requirements must be met before the pallet can be regarded as satisfactory. For example, if a deflection test were one of those for a timber pallet, the document would probably stipulate the maximum deflection permissible at any point of the supporting surface, whilst under load, and also the maximum amount of residual deformation permitted.

The work of these Groups must be finished in time for their proposals to be considered at the next plenary meeting of the committee in June, 1960.

To summarise, then, an ISO Technical Committee, representing thirty-five nations, is in the course of formulating a standard for pallets for the unit load method of materials handling—i.e. for international through-transit pallets as distinct from pallets for only national use, and also "factory pallets," "dock tool pallets" and pallets particularly suitable for stowing in manufacturers' own transport vehicles. Much of the committee's work has almost reached the ratification stage. This part concerns the standardisation of small flat pallets and, although the committee's recommendations are awaiting the approval of the necessary proportion of the Member Bodies, they are unlikely to be altered substantially and are now so well known that they are already having an important effect on industry.

Another part of the work is almost as far advanced—that concerned with box pallets, large pallets (of particular interest in sea transport) and an international glossary of terms relating to pallets, whilst the committee is now working to produce a draft recommendation for the specification and testing of timber pallets and a testing procedure for flat, box and post metal pallets.

Pallets are now in common use all over the world. There is a growing international traffic in palletised goods, particularly between countries separated only by land boundaries; there are pallet pools; there are pallet premises, there is automatic palletisation. Yet—it is pleasing to note— despite the continuing expansion of this handling method, the number of different sizes of pallets in use is decreasing.

The advantages of using standard pallets are becoming better known. Such pallets are of the most suitable sizes for handling into and out of conventional road and rail vehicles; all standard sizes can be handled easily by popular machines; concessions may be obtained from certain transport organisations when standard pallets are carried; pallet pools can usually be run best with pallets of only one size—and it is the practice to select a standard size.

In many countries of the world, road vehicles, railway trucks, short sea vessels and even big ships carrying large homogeneous cargoes coastwise, all have enough palletised traffic to justify special handling arrangements to be made. The important exception is the ocean-going general cargo vessel, in which such traffic is still rare. Yet, if more were forthcoming—if the many experiments bore more fruit—port authorities, employers of quay labour, most master stevedores and many shipping companies would welcome it, for a number of reasons. The use of pallets enables the full use to be made of the height of a shed, it reduces damage and pilferage risks, it involves less arduous physical labour and it speeds up handling so that ships are loaded and discharged more quickly and land transport vehicles are turned round in much less time than when cargo is shipped loose.

To conclude, it may be of interest to return to the subject of the international standardising body. ISO is a non-governmental organisation enjoying consultative status to the United Nations. Early in 1950, the United Nations circulated a document with the object of drawing attention to the need for co-ordinating, in a rational manner, the standardising activities of the various bodies occupied in this field and it proposed ISO as the organ competent to ensure this co-ordination, which would have the advantage of avoiding confusion in the setting up of contradictory standards by different bodies.

The first general assembly of ISO met in Paris in 1949, the second in New York in 1952, the third in Stockholm in 1955 and the most recent in Harrogate in 1958. At the end of 1959, there were some forty Member Bodies and nearly ninety technical committees working on an intriguing variety of subjects. These ranged from acoustics to aromatic hydrocarbons, couplings to cinematography, documentation to determination of viscosity, fire fighting equipment to fibre building board, hydraulic binders to hermetically sealed food containers and products in asbestos cement to, of course, pallets. Every technical committee mentioned had at least thirty members—i.e. nations participating and nations observing—and the United Kingdom, the U.S.A. and the U.S.S.R. were members of all of them. ISO believes that its work, besides having cultural value and facilitating international understanding, "contributes usefully to improvement of quality, increased production, lowering of prices and the expansion of exchange, as well as the reorganisation of markets".

The Surfacing of Wharves, Roads and Warehouse Floors in Dock Areas

General Considerations affecting Choice and Type of Materials

By LEO CRYSTAL, B.Sc.(Eng.), A.C.G.I., A.M.I.C.E.

(*Concluded from Page* 315)

5. **SITE CONDITIONS**

Site conditions materially influence the type of surfacing material.

A concrete "deck-on-piles" form of construction requires only a wearing surface to give protection to the structural concrete, whereas a mass, or block, wall form of quay retaining earth fill requires consideration of the complete pavement in which case the composition and thickness of the sub-base and base courses are selected in relation to the subgrade and the duties required of the pavement.

In those areas where the problem posed by the construction is, to all intents and purposes, the design of a pavement to satisfy given ground conditions and traffic duties, then the solution must be approached from the point of view of the road engineer, using all the means at his disposal, including compaction of the sub-base and possibly soil-cement stabilisation to provide a proper foundation; the methods for which are examined later.

Where the problem of choice of surface is bound up with the repair of existing pavements, other factors come in and these are also dealt with more fully later. Services within and on the ground, such as rail and crane tracks and service ducts, may sometimes affect the surfacing medium.

Rail and Crane Tracks

Unless a tramway section rail is used, some form of check rail is required to allow for flangeway and to give a level surface each side of the rail where unrestricted vehicle traffic across the rails is required. Possible settlement and consequent relaying of the track as well as eventual renewal are also factors to be considered in which the overall design of the wharf deck or road pavement is featured. Examples of the arrangements possible are given in Fig. 7 using various surfacing and pavement constructions.

Service Ducts

These are of two kinds. There is the open trench covered with removable covers or slabs and there is the duct or culvert accessible only through manholes or chambers at selected points. In the trench system the covers themselves can be one of several types, either concrete, steel, cast iron, or an infilling type where the infilling material is the same as the surfacing of adjoining parts of the quay.

This also applies to the covers of the manholes and access chambers of a duct or culvert system, where the latter detail is not a material factor generally in the surfacing. In some cases, however, it is preferred, or only possible, to lay pipes and cables near to the surface which must be thoroughly surrounded and topped to carry surface traffic and yet be able to be "got at" for renewal and repair. One of the bituminous types of surface is usually the best to use in this circumstance, although this need be local only over the pipe trench concerned.

Surface Water Drainage

Dock areas need well drained impermeable surfaces with efficient run-off facilities. The surfaces require to be laid to falls and cambers, the amount of which varies with the amount and intensity and frequency of rainfall to be expected within the dock area as well as the location. Flatter crossfalls can be used on wharf aprons and sheds where the gradient is uniform and in one direction and where the stormwater is shed continuously along the edge of the apron. On roads and areas where the run-off is collected in gullies at intervals a steeper crossfall is desirable, otherwise the stream of water running towards the gullies can spread out and affect a large proportion of the surface being drained. With these considerations in mind the crossfall may vary from 1 in 100 to 1 in 40.

A form of surface water drain which is used where rainfall is intense is shown in Fig. 8. This type of surface drain has a high capacity run-off, does not easily get choked, is easily maintained and yet does not present an impedance to vehicles traversing the area drained.

It has the advantage of long runs to suitable collecting culverts which can be sited most advantageously to avoid structural works such as shed and warehouse foundations.

6. **DESIGN of a new pavement on virgin or reclaimed ground**

The first consideration is the maximum wheel or other load. Even where wheels are in close proximity to each other, it is the single wheel load which is effective, provided the areas of subgrade stressed by each wheel do not overlap. An increase of 25% in the maximum wheel load is a reasonable amount to allow for impact, repetition of loading and the occurrence of multiple wheel loads.

The next, and major consideration, is evaluation of the capacity of the subgrade to withstand the applied load without undue deformation. This evaluation may be carried out by one of the three following methods.

(1) An empirical method based on a classification index of the subgrade which is used with standard curves derived from experience of the result of known pavement thicknesses on known subgrades. In using these curves they should be tested against known conditions within the experience of the user. The U.S. Public Roads Administration uses a group index defined as follows:

Group Index $= 0.2a + 0.005\ ac + 0.01\ bd$

where a = that portion of percentage of subgrade soil passing No. 200 mesh sieve greater than 35 and not exceeding 75, expressed as a positive whole number (0 to 40).

b = that portion of percentage of subgrade soil passing No. 200 sieve greater than 15 and not exceeding 55, expressed as a positive whole number (0 to 40).

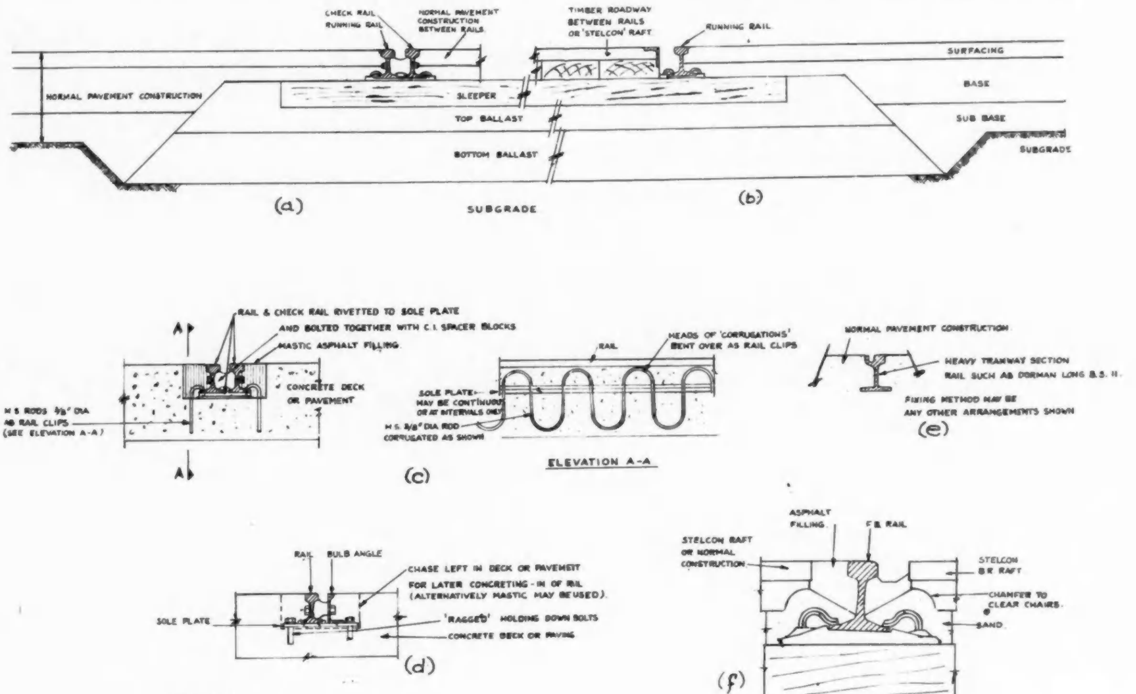
c = that portion of the numerical liquid limit greater than 40 and not exceeding 60, expressed as a positive whole number (0 to 20).

d = that portion of the numerical plasticity index greater than 10 and not exceeding 30, expressed as a positive whole number (0 to 20).

Tentative design curves are published by the Highways Research Board of the U.S.A. for use with their group index.

(2) The second method is semi-empirical based on load/penetration tests on the actual subgrade or on samples of the soil used in filling or obtained from the subgrade. There are two methods. The first, the C.B.R. test is generally in use for flexible pavements and the second, the modulus of soil reaction, for rigid pavements.

The California Bearing Ratio is an ad hoc test in which a standard cylindrical plunger 3 sq. inches in end cross-section is pushed into a sample of the soil at the penetration rate of 1/20 inch per minute. The load required to obtain a penetration of



NOTES

(1) Arrangements a, b, e and f are suitable for flexible pavement construction.
(2) Arrangements c, d and e are suitable for rigid pavement or wharf deck construction.
(3) Arrangements a and c are suitable for wharfside cranes with centre flange wheels.
(4) Holding down details of rail and check rail shown, are interchangeable.
(5) Arrangement c permits removal and renewal of rails with least disturbance to existing surfaces.

Fig. 7. Typical details of rail and crane tracks in pavements.

0.1 inches or 0.2 inches is expressed as a percentage of a standard load (3,000 lbs. for 0.1-in. and 4,500 lbs. for 0.2-in.) and is known as the California Bearing Ratio or C.B.R. For design purposes the C.B.R. value at 0.1 inches is usually used. Curves produced for use with the C.B.R. test give the overall thickness of pavement required from the C.B.R. value obtained. Related values of C.B.R. and pavement thickness are given in Fig. 9 for three values of wheel load. The C.B.R. test is applied to each of the structural parts of the pavement in turn; the C.B.R. increasing until it is over 80% in the top 6 inches of base course. Examples are given in Fig. 9. It should be noted that the thickness of the surfacing is included within the thickness of pavement which is a function of the C.B.R. value of the subgrade. The proportion of sub-base to base within the overall pavement thickness is dependent on the C.B.R. values of the materials used.

It is possible to carry out the C.B.R. test in-situ on the site of the proposed pavement and Fig. 10 shows the equipment and method. A much simpler in-situ test is the plate bearing test, details of which are shown in Fig. 11. In this test a 3-in. diameter plate is pushed into the sub-grade and the failure load recorded. There is a relationship for a given material between the failure load delivered by the plate bearing test and the C.B.R. value of that material. The relationship has been determined experimentally by P. J. M. Robinson and Tobias Lewis who expressed it in the form of the equation:

$$\log_{10} (\text{C.B.R.}) = 0.76837 \log_{10} (\text{plate load in lb.}) - 1.6442$$
$$(\text{plate load} = 3\text{-in. dia. plate})$$

The modulus of subgrade reaction is defined as the slope of a stress deformation curve obtained by field bearing tests. A plate 30 inches in diameter is placed on the surface of the subgrade (or 9 inches below the surface if this is virgin ground) and loaded in increments to produce an approximate penetration of .01 inches at each load application. The deflexion is measured when the movement has ceased and the load increments are continued until an overall deformation of 0.07 inches has been measured. A curve is drawn of applied pressure in lbs./sq. inch against penetration in inches. The modulus in lbs./sq. inch/inch is determined from the curve at a penetration of 0.05 inches. When a smaller diameter plate is used curves of correction for the modulus can be used.

(3) The third method of pavement design is based on theoretical stress distribution within the soil in conjunction with tests of soil strength. The two most well known are based on Boussinesq's elastic theory and Westergaard's analysis of the stresses within a concrete road slab. Westergaard uses the modulus of subgrade reaction described earlier.

The precise procedure for obtaining the C.B.R. value and the modulus of subgrade reaction as well as Westergaard's formula is given in standard reference books on Road Engineering.

7. MAINTENANCE AND RENEWALS

The type of surfacing has so far been dealt with on the merits of the surface to satisfy user requirements and on the assump-

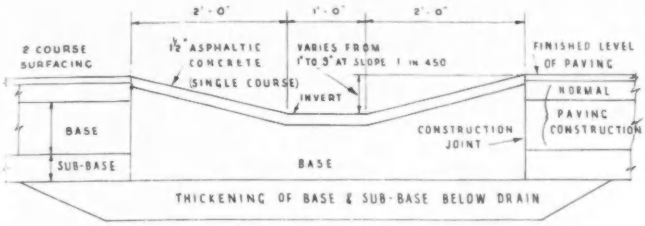


Fig. 8. Cross-section through open type surface drain.

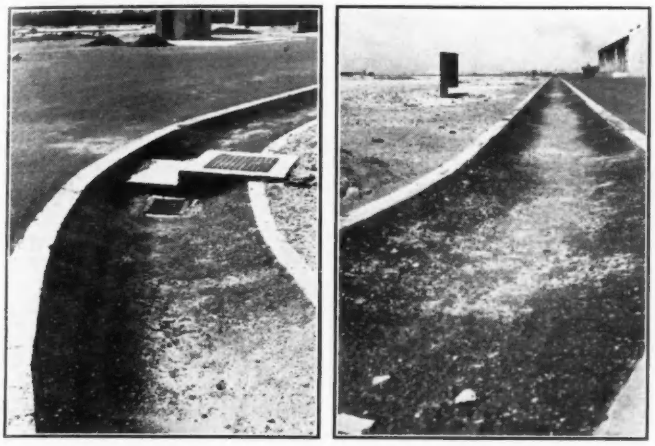


Fig. 8a. Open type surface water drain showing long run and typical outlet.

tion that the pavement for which the surface is intended is new construction.

There is, however, the wide field of repairs and renewals to existing pavements and surfaces where the choice of surfacing and remedial treatment is conditioned by the state of the existing surface and pavement as a whole. In the following paragraphs various conditions of failure are considered and the necessary remedial action described. Reference should be made to Fig. 1 for the definition of terms related to the component parts of a pavement.

Existing Bituminous Surfaced Pavements

The failure of these pavements can be due to either:

(a) Inadequate construction for the required load carrying capacity, or

(b) Inherent instability of the surface.

Inadequate Construction

If the pavement is not adequately designed to distribute the applied load, so that the subgrade is overstressed, local depressions and then cracks develop in the surface which leads to its breaking up and to simultaneous deterioration of the pavement. The only remedy is to reinstate the pavement including its complete redesign as earlier described and renewal.

Remedial measures applied to the surface only will not last and are likely to cause continuing trouble and heavy maintenance costs.

Depending on the subgrade conditions the sub-base and base may consist of ballast, stone pitching, concrete, or a combination of these. For an asphaltic concrete surface good results have been achieved with a base consisting of "run-of-pit" gravel containing broken stone with some fines, mixed with about 5% normal Portland cement.

Drainage is a most important factor in the design of the sub-base and base and the design must always take full cognisance of this.

The surfacing may be applied directly to the base or there may be an intervening regulating course; the surfacing itself may be of single or two-course construction.

In this form of remedial work in which the old pavement is broken out and rebuilt to correct design, the choice of surfacing is dependent on the service conditions described earlier.

Inherent Instability of the Surface

This is due to a number of factors all leading to the eventual disintegration of the surface, and which may occur singly or combined.

(a) A soft aggregate will wear and crush under the impact of iron shod wheels and caterpillar tracks. This also applies to an insufficiently dense mixture.

(b) Inadequate binder strength or content allows the stones of the surface to be sucked out by the passage of pneumatic tyred traffic or moved by steel tracks.

(c) The grade of binder used, or the temperature at which the mixture was mixed and/or laid may be unsuitable for the service requirements so that the surface has such defects as ridging, creep, fatting-up, etc.

Before deciding on a remedy it is necessary to ascertain by laboratory tests on samples of the pavement whether one or more of the above causes of failure is contributory. These are carried out by standardised methods and procedures. Having made the assessment one can then proceed as follows:

In the case of (a) and (b) above, that is a soft aggregate or inadequate or incorrect binder, it is preferable to strip the bituminous surface, roll and regrade the base and apply a new surface. Alternatively, the application of an improved wearing course would be satisfactory if the pavement is good in all other aspects. Where, as in (c) above, the surface contains a suitable binder and stone content but is too "fat" or has become corrugated it is possible to heat the surface and plane it to the correct shape followed by rolling chippings into the surface.

Existing Sett Paved Area (see Fig. 12)

The renewal of this type of surfacing is usually called for when the surfaces of the setts have become smooth and/or irregularities in level between the setts make travelling of traffic, plant and personnel, difficult and even dangerous.

The remedy is to rebed and relay the setts or to cover the setts with a new surface, the setts usually making an ideal foundation. Alternatively the surface may be hammer dressed.

A case for rebedding and relaying the setts can be made if the

CBR	— inches — Construction Thickness WHEEL LOAD - lbs		
Percent	7,000	9,000	12,000
2	22	24½	27½
4	15½	17	19½
6	12	13½	15½
10	9	10	11½
15	7½	8	9
20	6½	7	7½
30	5	5½	6
40	4	4½	5
50	3½	4	4½
60	3	3½	4
80	2½	3	3½

Duty: Heavy traffic (12,000 lb. wheel load: more than 300 vehicles a day), **Pavement Thickness:** 11½ inches.

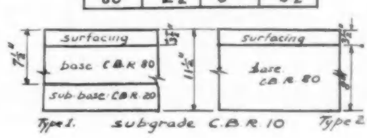
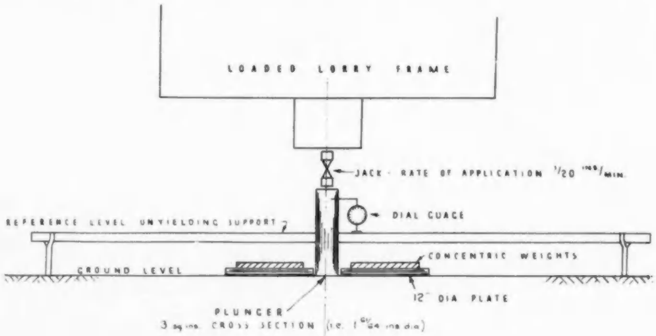


Fig. 9. Table of C.B.R. values and thickness of construction. Also example of design by this method.

subgrade is compact and well drained. The sub-base can then be a lean concrete or cement stabilised ballast, the setts being bedded directly on to this sub-base while it is still green and jointed in cement-sand mortar.

Where it is decided to cover the setts with a new surface, the setts become the equivalent of the base course of a pavement in which the choice of surfacing is dependent on two factors. One is that it should be capable of evening out the irregularities in



NOTE ON JACK

(1) If an hydraulic load recording jack is used the load can be applied directly to the plunger as shown.
(2) If a screw feed jack is used the load must be applied to the plunger through a proving ring for measuring the load. Two dial gauges are needed; one for the compression in the ring and the other for deflection of the plunger.

Fig. 10. Method of carrying out in-situ C.B.R. test.

the surface of the setts, at the same time tying in with existing fixed surface levels; i.e. in effect a regulating course; the other is that the wearing surface should conform to the traffic conditions obtaining. Fine cold asphalt is frequently used for this type of repair.

Existing Concrete Pavements

The failure of these pavements is usually attributable to one or more of three causes:

(a) The sub-base and subgrade may be inadequate to give uniform and/or sufficient support to the concrete slab so that uneven settlement occurs. Unless the concrete is heavily reinforced, cracking and eventual break up of the slab will result.

The remedy here obviously lies in giving the concrete slab the support it requires by strengthening the sub-base so that the underlying subgrade is not subjected to a greater load intensity than it can safely support. It might be possible to effect this without completely breaking up and having to renew the slab. Concrete slabs designed for this purpose, and capable of lifting and resetting, are worth considering in situations where continuing settlement occurs.

(b) The positions and spacing of expansion and construction joints may be such as to lead to "sympathetic" cracking in adjacent slabs, or within the slab itself. This in itself does not constitute a failure, but the cracks so developed should be sealed to keep the sub-base and subgrade dry.

(c) Repairs, due to the wearing of the surface under normal traffic and splitting due to impact and point blows, are not a difficult matter if the top 3 to 4 inches of the concrete slab is a wearing course or screed specifically applied, with its replacement ultimately allowed for in maintenance schemes. The replacing screed can either be a cement concrete screed with the addition of surface hardeners or a bituminous mixture. It must be borne in mind that a wearing surface laid on concrete after the latter has set, must be properly bonded or it will flake off. Also too much working of the surface screed will result in the segregation of cement from the mix giving a "fat" brittle surface on top of a "lean" base. If prevention of damage to the surface of the concrete is not catered for by a screed during first construction, then in the due course of maintaining the slab, a screed of one of the above-mentioned types would be called for, if the slab itself is to be protected from disintegration and subsequent but costly, renewal. This is particularly true where the concrete slab forms an integral part of the structure, such as a deck-on-piles quay or suspended floor of a warehouse.

8. SPECIFICATION

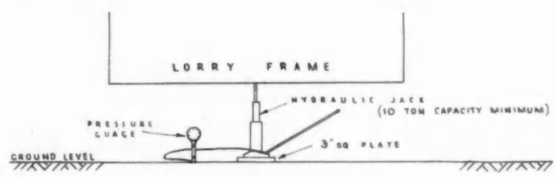
It is only possible to cover specifications for surfacing and pavement works in general terms, as each case must be decided upon its merits. However, some indication of the kind of work involved is here given.

It is, of course, necessary to differentiate between surfacings and pavements on natural or filled ground and surfacings on structural work such as wharves and quays. In the latter case, referring to Fig. 1 the constructional work may be considered as the base course and the specification for the surfacing will be brought in later.

At the present juncture, it is, therefore, intended to confine the remarks to pavements built on natural or filled ground.

The subgrade. The subgrade material should be classified on the basis of simple laboratory tests such as particle size analysis and the plasticity tests. Further tests comparing the natural moisture content and density with the optimum conditions will indicate the extent to which compaction of the subgrade needs to be carried out, and if possible this subgrade should have a density at least 90% of the optimum density as given by B.S. 1377. C.B.R. tests and load penetration tests should be used to determine the overall pavement thickness. Peat and highly organic soils should be excavated and replaced with more stable material and frost susceptible soils such as chalk and silt should be excluded from the frost zone. Measures to adequately drain the subgrade should be taken.

The sub-base and base. A stable, flexible base (i.e. one that is capable of resistance to lateral displacement under load) consists of a mixture of coarse aggregate (gravel, crushed rock, etc.) fine aggregate (sand or crushed rock) silt and clay in suitable



NOTE ON FAILURE LOAD.

This appears to have a sharply defined value. With the type of equipment shown either a load is reached which further pumping of the jack does not cause to rise appreciably or permanently, or else a rapid descent of the jack into the ground occurs.

Fig. 11. Method of carrying out plate failure load test.

proportions and fully compacted. A stabilising agent such as cement or bitumen may be added. In the limit the admixture of cement to coarse and fine aggregate results in a concrete base which brings the design of the base within that for a rigid type of pavement. Much work has been done on the limits of particle size distribution of a granular mass to obtain the best performance for a mechanically stabilised base and information such as will assist in specifying or obtaining the material for a base course is noted in the bibliography appended.

Surfacing Specifications: (a) Concrete

The mix should be proportioned to give a minimum compressive strength at 28 days of 4,000 lbs. per square inch with a cement content of about 15%. The water cement ratio should be a minimum to obtain full compaction and some form of vibrating screed is desirable to ensure that this is obtained.

The coarse aggregate should be clean, washed river or pit gravel and the fine aggregate should be clean washed sharp river or pit sand. Unless the slab is thicker than about 8-in. the maximum size of aggregate should not exceed ¾-in. Where suitable aggregate is not available, the use of a grouted aggregate process such as Colcrete is suggested. In this method the coarse aggregate should be uniformly sized 2½-in.—1½-in. and the fine aggregate sharp clean sand. The large aggregate is placed in situ and the sand is mixed with normal Portland cement in a special mixer producing a colloidal grout which is then pumped into the aggregate or allowed to penetrate by gravity. The use of an intrusion aid may be allowed. This method permits large areas to be prepared and completed quite quickly.

(b) Bituminous Surfaces

The different types of bituminous surface mentioned earlier are the subject of British Standards as well as publications of the asphalt, bitumen, and tar, industries. These publications describe the types of aggregate and grading for base and wearing courses in two course work as well as that for single course multi-purpose surfaces. It is beyond the scope of this article to describe the variety of bituminous mixes available for individual classes of work but the following information may serve to direct the reader further.

The coarse aggregate should consist of crushed stone or gravel, clean hard and free from excessive dust or flaky pieces. The fine aggregate should be clean, sharp sand or crusher-run without dust or a mixture of the two. The filler incorporated in the mix should be normal Portland Cement, 75% of which should pass a 200 mesh sieve.

The percentage of bitumen or tar required will depend on the grading of the mixture selected for the job mix and on the void content of the mixed aggregate. The characteristics of the binder, e.g. viscosity or penetration number, are functions of the service requirements and the plant available for heating and spreading the mixtures.

In this connection a knowledge of the viscosity/temperature relationship of the bitumen or tar to be used, applied to the construction procedures, will materially assist in establishing the correct temeperatures of mixing and laying as well as improving quality control of the work.

Comprehensive tables showing limits of grading, mix proportions and binder contents in bituminous mixtures are given in British Standards and other publications.

Fig. 12a. Worn and irregular setts.

Fig. 12b. Subsidence of the foundation to an otherwise reasonable sett paving.

Fig. 12c. Relaying stone setts.

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New Transit Sheds for King George Dock, Hull

British Transport Docks have placed a contract for the construction of two single-storey transit sheds at No. 12 Quay, King George Dock, Hull. The new sheds, which are each 500-ft. long by 150-ft. wide will, with associated works to improve rail and road facilities, complete the modernisation of this quay which has recently been reconstructed in concrete.

The sheds will have steel frames and brick walls, and the roofs will be supported by single-span steel frames. This type of roof structure will eliminate the need for interior supports and so will give freedom of movement to a fleet of modern mechanical handling appliances over a total floor area of 150,000 sq. ft. Each shed will have nine doors facing the quayside and nine on the landward side, the latter giving access to the rail-loading platforms. There will be electrically-operated steel shutter doors at the ends of the sheds where internal platforms will be provided for dealing with road traffic.

The main contractors for the work are A. Monk and Co. Ltd., of Padgate, Warrington. Steelwork will be provided and erected by the South Durham Steel and Iron Co. Ltd., of Middlesbrough, as sub-contractors. The contract is scheduled for completion early next year.

Liverpool Observatory and Tidal Institute

Abstracts from the Annual Report for 1959

Variation in Tidal Differences

The practice of publishing predictions for " secondary " ports by means of differences applied to the predictions for " standard " ports is an old and valuable method, for these secondary ports do not require predictions by the more elaborate methods, partly because of the lack of suitable data and partly because of expense. Differences have commonly been taken at Full and Change of the moon and also at Quadrature so far as times are concerned, but at springs and neaps for height differences. It has been generally assumed that for other times and heights interpolation and extrapolation in and from these differences would give satisfactory results. Such differences are generally acknowledged to be only approximate, and an investigation has been carried out by Mr. Rossiter to amplify some results obtained about 20 years ago by the Director, who showed that so far as the two principal constituents (M_2, S_2) were concerned the differences depend upon whether the tide is increasing from neaps to springs or decreasing from springs to neaps, and that the differences are uniquely determined in terms of high water time but not in terms of high water height. These results were confirmed by Mr. Rossiter and he amplified the investigation to include a third harmonic constituent (N_2), and fully illustrated the results.

Mean Sea Level

Much activity during the year has been associated with problems arising in relation to mean sea level. It was reported last year that it was proposed by the International Association of Oceanography and the Union of Geodesy and Geophysics that a Permanent Service for Mean Sea Level should be carried on by the staff of the Tidal Institute and that this proposal had been accepted by the International Council of Scientific Unions, with financial assistance from the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

In October it was found possible to have a meeting of the Committee for Mean Sea Level of the International Association of Oceanography, and proposals were formulated for the encouragement of all tidal authorities to maintain tide gauges in perfect condition.

A major activity has been the compilation of the monthly and annual mean heights of sea level, values of which have been sent to the Institute by many national authorities, and a volume has been printed and is in course of distribution. This is a continuation of the series of volumes published at five-year intervals by the International Association of Oceanography, but the present volume gives data for the International Geophysical Year, 1957 to 1958. Some IGY data may not have been included because of the delay in sending the material. The opportunity was taken to include also some unpublished data for earlier years.

It was reported last year that the National Committee for Oceanographic and Meteorological Research had appointed a sub-committee to deal with matters concerning mean sea level in this country and preparations are being made for the analytical work to be done on the large number of records that will become available. Research into the various methods which have been proposed, having regard to accuracy as well as costs, has been carried out.

Mean Sea Level and Geodesy

For several years past the International Association of Geodesy has been concerned with a project for correlating the levelling networks in Europe. Spirit-levelling, of course, has been the main method of survey, and the standard of accuracy in this has been greatly increased in recent years. Nevertheless, it was proposed to compare the results with the values of mean sea level as obtained from many tide gauges on the coasts of Europe. The datum-planes for these tide-gauges were measured in relation to local and well-established benchmarks, and the values of mean sea level reduced to the value corresponding to the international datum. It was expected that these would be affected by many oceanographical and meteorological influences. When all the preliminary processes had been completed by the geodesists arrangements were made to have a symposium on the subject and to request the assistance of the Permanent Service of Mean Sea Level, and of oceanographers. Accordingly the Governing Committee authorised an invitation to have the conference in Liverpool in October, and this was accepted. Much organisation was necessary for such a conference and the Mersey Docks and Harbour Board were extremely helpful in providing a room and facilities.

The five days of the conference were taken up with reports of the geodetic work, but rather more than half the time was spent on the discussion of meterological and oceanographical influences on mean sea level. The Director had written a paper on " Mean Sea Level and Geodesy ", and had made some investigations on the meteorological effects.

Interaction Between Storm Surge and Tide

In 1928 the Director of the Institute remarked that storm surges in the Thames were prone to be at a maximum height above the tide at about half-tide on the rising tide. This is not very noticeable elsewhere than the Thames. In 1956 the Director carried out an investigation of tide and surge in a long uniform gulf, the conclusions being that though there was definite interaction it was a function of the relative phase of surge and tide and there was no evidence of there being an association of the largest surges with half-tide in the gulf. This was an experimental method in reducing the mathematical formulae to a manageable form for computation, and the methods were helpful to other investigators. Mr. Rossiter developed the scheme of calculation appropriate to an expanding estuary such as the Thames, but with such simplifications from the conditions of the actual estuary as the choice of a constant depth and of an exponential form for the width. A further modification was suggested by some work of Professor Hansen, of Germany. Previously all integrations had been made with distance along the channel as the variable and for such it was necessary to specify conditions at the barrier and to approximate by iteration to conditions at the entrance. The new method was suggested by Mr. Otter of Rendel, Palmer and Tritton and was approved by the Institute as integrations were effected with the time instead of distance as the variable. It was an advantage that conditions at the mouth of the estuary could be assumed for a tide alone or for a tide and surge and the integrations could be made to correspond to the oscillation at the mouth invading still water. It was easy to satisfy the conditions at the closed end of the estuary and to continue the integrations to verify that the solution was exact all along the channel. The solution rapidly approached its final value. One case only has been computed but other cases will be investigated by the aid of the DEUCE electronic computer recently acquired for the Department of Applied Mathematics in the University of Liverpool. The results so far seem to be encouraging.

Mr. Lennon has continued his investigation of the frequency of occurrence of abnormal levels for west coast ports and this work has now been extended to cover eleven localities in all. Considerable work has been done in investigating various techniques for extrapolation from observed data so that an estimate can be made for the frequency with which the occurrence of certain danger levels can be expected. In this respect there appears to be no adequate statistical solution for the treatment of the data. The statistical theory for extreme values due to E. J. Gumbel, in particular, has been applied and shown to be un-

satisfactory in this context. It is now felt that an individual fit of a linear logarithmic function to a selected range of the observed data, each port considered separately, probably provides the most suitable values for extrapolation, and at the same time is capable of presentation in a simple form to local engineers to whom these results are already being of great assistance.

An encouraging adjunct to this study has shown that interaction between tide and surge is certainly present, at least in the cases of Bristol and Liverpool and furthermore that this acts as a safety factor. At Bristol for example the probability of a significant surge contribution to high water at neaps is more than twice that at springs.

Earth Tide Symposium at Trieste

The Third Symposium on Earth Tides was held at Trieste for a week in July, preceding symposia having taken place at Brussels and Munich in the two preceding years. Mr. Lennon attended as the national representative, appointed by the Royal Society. One of the principal subjects was that of the reports on the observations taken at a large number of places during the International Geophysical Year, and Mr. Lennon gave a report on the work done at Bidston. The equipment at Bidston consists of two Milne Shaw seismometers belonging to the Observatory and a Zöllner pendulum and accessory apparatus first installed by Professor Tomaschek. The Milne Shaw pendulums are mounted on pillars which have been in situ for over 50 years and which have proved to be remarkably stable. The Zöllner pendulum is located on a metal plate mounted a few inches above rock level and this has been undisturbed for the last seven years. The Milne Shaw instruments register in the North/South and East/West directions and the Zöllner pendulum registers in the East/West direction. The indications of the latter instrument should be strictly comparable with those of one of the Milne Shaw instruments, but there are discrepancies. These instruments register the earth tide, which is mainly seasonal for the two Milne Shaw instruments but the Zöllner instrument shows also a continuous drift to the west. It was considered unwise to modify the mounting of the Zöllner instrument because of the length of time required for "settling in." Special care is needed in calibrating these extremely sensitive instruments and there are uncertainties which lead to a difference of about 20% in the amplitudes of oscillation indicated by the Zöllner and Milne Shaw instruments. This does not mean that the observations are invalid as each instrument is consistent in its recordings month by month, but investigation of the causes of the difference will ultimately have to be made. Analyses for 19 concurrent 29-day "months" have been made in each case. Special attention was paid to the diurnal constituents with a view to estimating the effects of changes in temperature, and the situation of the Observatory on a sandstone ridge running in a North/South direction seemed to be responsible for an observed tilt to the west, which was a maximum at sunset, with a maximum to the east at sunrise. Much patience and skill are yet required to consider the causes of the non-tidal contributions to the tilt.

At Trieste, Mr. Lennon advised against the acceptance of results from a single instrument without great caution. At Bidston where observing conditions are ideal in that the tidal movements are more than ten times greater than would be experienced in continental stations, experience from three instruments over a number of years shows that difficulties of calibration, seasonal variations in amplitude, perturbations by non-tidal effects and instrumental drift, all contribute to cast doubt upon the accuracy of results and leave much to be done in the future.

There had been a close examination of the methods of analysis used for the I.G.Y. observations made in many countries by many methods, owing to the varying quality of the records, and some method of assessing the accuracy of the results was desired. The Director and Mr. Lennon investigated this matter for the methods used at the Observatory and reported their findings to the Symposium. A simple method was suggested for evaluating the casual error of the observations.

The Attraction of Ocean Tides at Bidston

Special reference should be made to an investigation by Mr. Lennon, on which he reported at Trieste. The periodic deviation of the vertical in sympathy with the flux of tidal waters is of particular interest in the investigation of earth tides by tilt meters. The phenomenon is particularly important at Bidston, situated as it is on a peninsula within two miles of the shores of the Irish Sea in which are experienced tides up to 30-ft. in range. Of the total tilt observed at Bidston less than one tenth can be attributed to the true earth tide. The remainder is due to the effects of oceanic loading and oceanic attraction. In earlier work Doodson and Corkan were able to separate the true earth tide from the loading tide which was assumed to be in phase with the local tides. With the increase of observational results it became desirable to explore the degree of tilts due to tidal loading and tidal attraction. Unfortunately knowledge of the oceanic tides falls far short of the precision required for this class of investigation. The basis of the study was the charts of the distribution of the principal lunar semidiurnal tide as determined by Proudman and Doodson in 1924 for the North Sea and by Doodson and Corkan in 1931 for the English Channel and Irish Sea. For the present investigation Mr. Lennon extended these charts to cover adjacent areas to the north and to the west of Ireland. The contributions from separate areas of the adjacent seas, channels, and ocean were then calculated according to the known theories of attraction. Special attention needed to be paid to the nearest estuaries where it was known that large areas dried out at low water, and the necessary corrections were made. Thus the effects for all areas were considered and the ultimate results showed that the attractive effects and the direct loading effects were in the ratio of one to three.

Although knowledge of the disposition of the tidal constituents in the oceans is not sufficient for the direct computation of any but the M_2 contituent of tidal attraction, Mr. Lennon has succeeded in obtaining a good inference of S_2 and N_2 values using an elaborate reduction of observed values of amplitude and phase relationships weighted in accordance with their contribution to attraction.

Mr. Lennon hopes to complete this paper and to publish the full details as soon as possible.

Miscellaneous

Advice was given during the year concerning a barrage proposed for Milford Haven, as to the consequences of temperature changes affecting agriculture, and Mr. Rossiter attended the House of Lords to give evidence, though he was not called upon.

Mr. Lennon participated by invitation in a geophysical discussion held in the rooms of the Royal Astronomical Society, the subject being that of the Automatic Reduction of Geophysical Data. Mr. Lennon pointed out the special difficulties encountered in the treatment of earth tide data; in particular the many perturbations experienced in the instrumental records, some of which can introduce a spurious tidal period. The methods evolved at the Tidal Institute were demonstrated and explanation was given as to why these methods were preferred to the automatic reduction of the data by digital computer.

The number of full tidal predictions for 1961 shows a slight increase on last year. Hourly height predictions for Felixstowe, Lowestoft, Immingham, Tyne Entrance and Aberdeen have been computed up to April 1960, on behalf of the East Coast Flood Warning Service. Also hourly predictions for Stornoway and Lerwick for special periods have been furnished to the National Institute of Oceanography for researches on storm surges.

Coastal Engineering Study at Fort Pierce, Florida

Investigation into Causes of Erosion of Sandy Beach

(By the Coastal Engineering Laboratory Staff, University of Florida)

History and Morphology

FOR many miles north of Palm Beach, the mainland of the Atlantic coast of Florida, U.S.A. has a series of sandbank barriers running approximately parallel with the coast line, and between them enclosing stretches of water. Over the years comminuted sand and shell have been built up by wave action on the shallow continental shelf into sand spits and then eventually, with the assistance of the wind, this material has been formed into lagoons, totally or partially enclosed. At all times the sand is on the move; the partially enclosed lagoon spit maybe links up with the one in front, or totally enclosed lagoon due to over wash in some abnormal height of hurricane tide once more makes connection with the sea.

At times, as in the present case, it is found convenient for commercial purposes to open an outlet to a ready made harbour and established industry.

One of the fundamentals in the laws governing the equilibrium of the material of a naturally formed beach is that any interference with it of sizeable dimension will cause a change in the regimen, not only locally but maybe some distance away.

Here we have a case where an existing natural inlet much further north was replaced by one artificially made. About 1920-1929 local interests determined upon expansion and built two rubble moles, ('jetties' in American parlance) of tipped rock. The north mole is 2,000-ft. long and the south mole 1,200-ft. long with the channel between dredged to a depth of 25-ft. at low water (see Fig. 1).

In November 1957 after several years of anxiety and discussion on the security of the Hutchinson Island barrier it was decided by the recently appointed Fort Pierce Erosion Board to initiate technical studies. They then asked the Coastal Engineering Laboratory of the Florida University, to examine the problem.

Purpose of the Study

The three main points of enquiry were:

(i) to gather data relevant to the erosion and accretion conditions within the district area.

(ii) to make recommendations for protective measures.

(iii) to determine measures to prevent the breakthrough or washout of the barrier south of the present inlet during storm conditions.

Ocean Swell and Wind

Since there was no record of weather data for the district of Fort Pierce recourse had to be made to that published by the Beach Erosion Board, Corps of Engineers, U.S. Army, for the Palm Beach area.

Fig. 2 shows the result for the average yearly winds; it indicates that the velocity was greater from the north-east sector than from the south-east sector, but that the duration and wind movement were greater from the south-east than from the north-east sector: the strongest wind is from the north-east but the duration is only 15 per cent of the time whereas the duration and wind movement is greater from the south-east and lasts 32% of the cumulative time.

In the swell rose diagram (Fig. 3) the length of the bar denotes the percentage of the time that swells of each type have been moving from or near the given direction. The figure in the centre of the diagram indicates the percentage of calms. Plotted for the ten year period 1932-1942.

The wind diagram (Fig. 2) is based on six-hourly readings over eight years from July 1938 to July 1946 by the U.S.A. Weather Bureau at West Palm Beach. The bars in length and width show velocities in miles per hour and the cumulative duration in the given direction respectively.

It will be noted that high swells occur, over 12-ft., about 3.7 per cent of the time from the north-east and about 2 per cent from the east: high swells from other directions occur only a fraction of one per cent of the time.

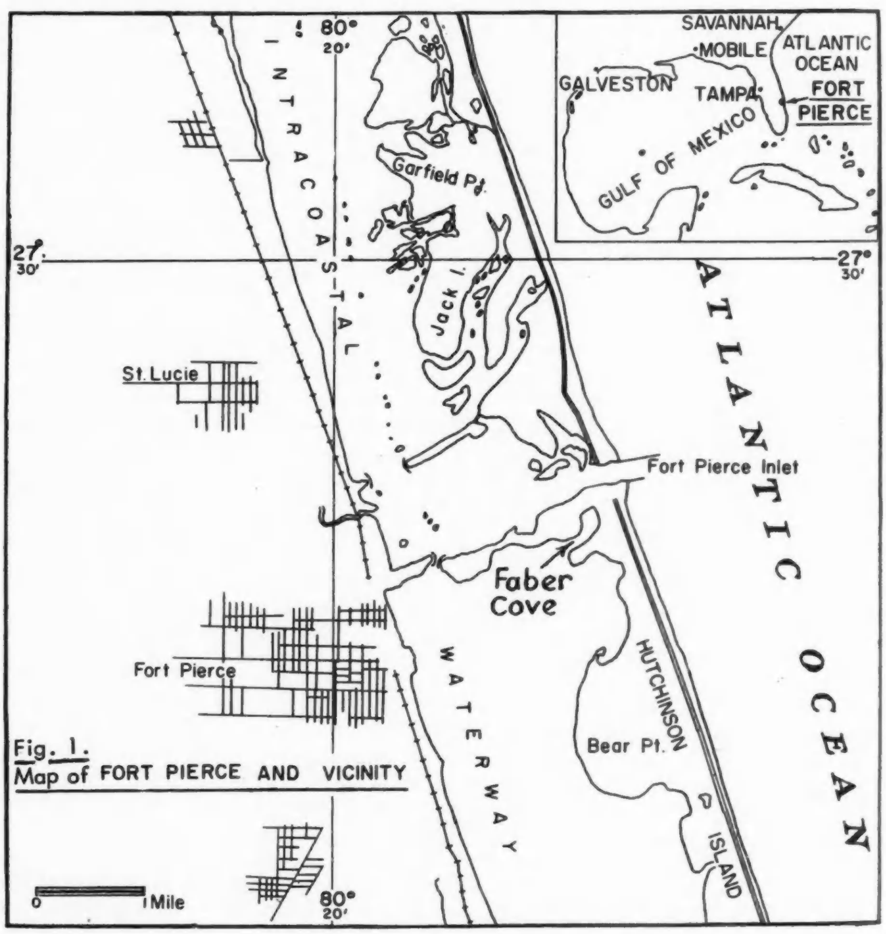


Fig. 1. Map of FORT PIERCE AND VICINITY

Effect of Hurricane Winds

The 30-ft. contour depth at Miami Beach as well as at Fort Pierce, is located at about 2,000 yards from the shore line; the 60-ft. contour at 1.75 and 7 nautical miles, respectively. If we consider a storm with the same wind velocities at both places and with the same direction of wind at a wind velocity of 100 miles per hour, the tide elevation at Fort Pierce will be one to two feet higher than at Miami Beach.

To improve the estimate of the frequency of the tide elevation it is proposed to use the information obtained by U.S. Geological Survey (Oct. Hurricane 1953) up to the 5-ft. tide and, above this tide elevation to use the frequencies for Miami Beach reduced by 50 per cent thus:—

4-ft. or higher above mean sea level—once in 2 years.
5-ft. or higher above mean sea level—once in 10-20 years.
6-ft. or higher above mean sea level—once in 15-30 years.
7-ft. or higher above mean sea level—once in 30-60 years.

Tides and Currents

Tides are semi-diurnal, two low and two high each day with mean tidal range at Fort Pierce of 2.6-ft. (ordinary) and spring range 3-ft. Hurricane winds are widely variable and information is sparse. The October (1953) hurricane gave rise to an ocean tide of 5-ft. above mean sea level at Eau Gallie and before that from October (1944) to October (1953) the tide no less than six times exceeded 4-ft. above mean sea level.

Apart from the shallowness of the foreshore, the angle of approach of a hurricane appears to be an important factor in the generation of hurricane tides.

Very little is known about ocean currents in this area.

A Price current meter was used in the middle of Fort Pierce Inlet channel for about 10 hours on February 27, 1958, the results of which are shown in fig. 5. The maximum current velocity observed was 4.4-ft. per sec. at low water in the ocean. The tidal range that day was 2.2-ft.

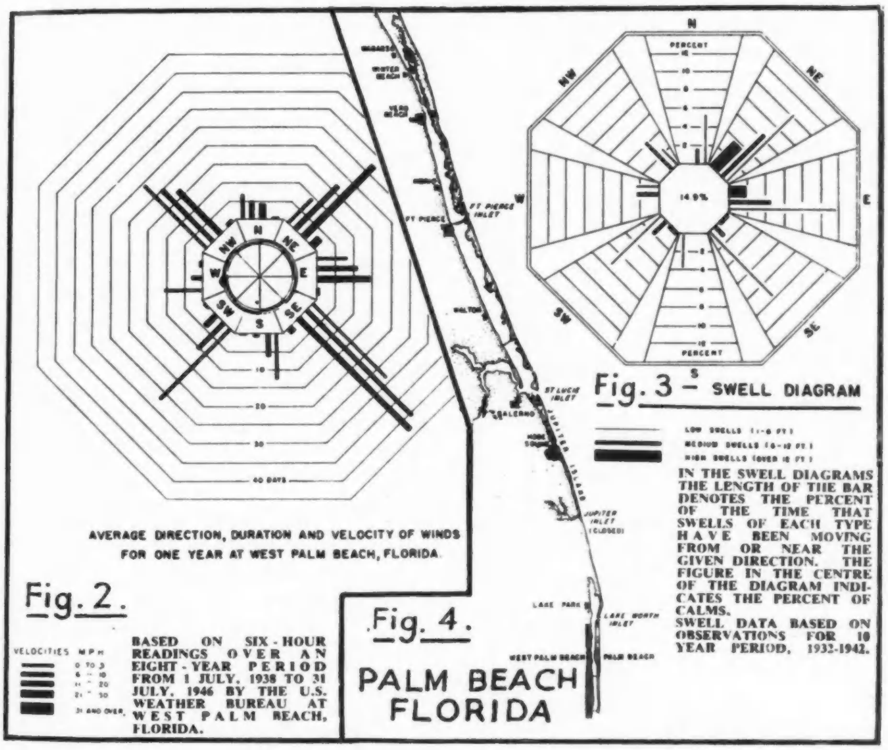


Fig. 2. Fig. 3 — SWELL DIAGRAM. Fig. 4.

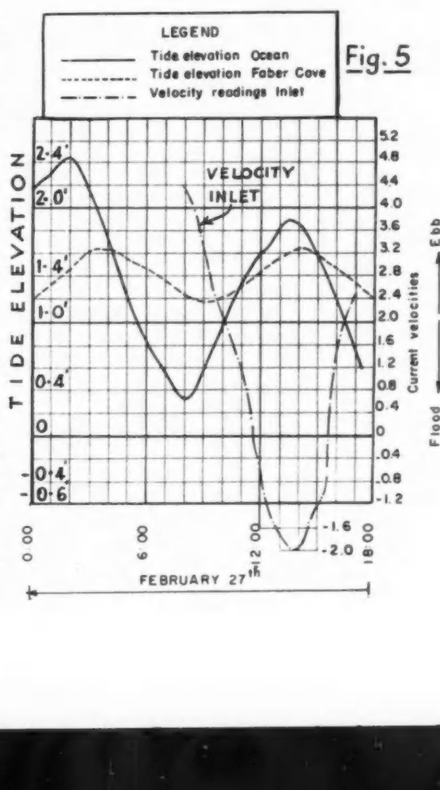


Fig. 5

Littoral Drift

An examination of the monthly averages for a ten year period indicates that from September through February the prevailing and predominant swells approach from directions which set up a southerly drift. During March, April and May the resulting directions of drift are uncertain. From June through August the prevailing directions of swells create a northerly drift. The severity of north-east winds which generate waves from the same direction compensate for this situation and the predominant drift is from north to south.

Before the inlet was made sand material from the north drifted over and nourished the beaches of Hutchinson Island. The inlet interrupted this, sand now accumulates on the north beach alongside the mole and some is washed through and around the head into the channel and bay shoals. Later, on the ebb tide the sand is carried by the strong currents in the inlet out into the sea again, where part of it returns to the littoral drift zone whilst another part apparently is lost to deep water and unknown drift conditions (see Fig. 4).

Precise figures for the amount of the littoral drift are not known but it has been estimated to be between 200,000 to 250,000 cu. yd. per year and that the bulk takes place between contours +3-ft. and −6-ft.

Development of the Erosion.

Samples of sand from the sea bed were taken along the full length of the foreshore inlet and bay. The differences of this material on the two sides of the inlet were well noted and easily recognised in the laboratory. In any case classifying was helpful and gave ample confirmation that a large amount of material passed through the rubble mole into the inlet channel. The average recession of the shoreline south of the inlet per annum was 6-ft.

Influence of the Fort Pierce Inlet on the Littoral Drift

Let N. = Net amount of littoral drift material entering the area from the north (see fig. 6).
S. = Net amount of littoral drift material leaving the area for southward drift.
a. = Amount of littoral drift material deposited permanently in area north of northern mole.
b. = Amount of material passing through and over the northern mole into the inlet.
c. = Amount of material sucked into the inlet by flood currents.
d. = Amount of material deposited in

the inlet channel and on the bay shoals ($d=d_1+d_2+d_3$).

e. = Amount of material jetted out into the sea by the inlet ebb currents.

f. = Amount of material brought out by the inlet ebb currents and deposited in deep water outside the littoral zone.

g. = Net amount of the material in the offshore area south of the inlet which by-passed the inlet.

h. = Amount of material passing through or over the southern jetty into the inlet.

k. = Net amount of the material eroded from the beach and near offshore area south of the inlet from the southern mole to the point where normal littoral drift has been re-established and leeside erosion is not evident.

The following material-balance equations can be written, assuming similar profiles, material and wave action on both sides of the inlet.

$N.=S.=g+k$

$N.=a+d+f+g$

$d+e=b+c+h$

This gives $e=b+c+h-d$

$f=k-a-d$

$e-f=b+c+h+a-k$

It was possible from information supplied by the Dredging section of the Corps of Engineers, and from that obtained by the Study Group, to fix the approximate value of some of these factors.

N. = S. = 200,000 to 250,000 cu. yds. (net southward drift).

k = 100,000 cu. yds.

a = 20,000 cu. yds.

d = 40,000 cu. yds. (26.000 dredged p.a. and the rest in the bay shoals).

g = 100,000 to 150,000 cu. yds

inserting values

f = 40,000 cu. yds.

$e=(b+c+h)-40{,}000$ cu. yds.

This means that 40,000 cu. yds. per annum are lost in deep water. It is assumed that 80 per cent of the littoral drift or 160,000 cu. yds. migrate within the 18-ft. contour (depth).

Overwash and Flooding

The main part of the barrier at Fort Pierce inlet is situated 5 to 6-ft. above mean low water level. Along the shore is a narrow strip of sand dunes with heights 10-ft. to 12-ft above mean low water level. The lowest dunes are about 3 miles south of the inlet near the popular public beach. The width of the barrier varies between 200-ft. and 6,000-ft. (see Fig. 1).

Because of the difference of the tidal range between the waters of the bay and the ocean—which normally is about 2-ft., (see Figs. 1 and 4)—it is more likely that a breakthrough may occur during the first storm and high tide either north of the inlet or through Hutchinson Island. The danger in the neighbourhood of the inlet is therefore not that of a breakthrough but that of overwash of the barrier caused by a combination of wave uprush and storm.

Total, 100,000 cu. yds. per year.

Such an amount equates with that which is eroded from the area south of the inlet over a distance of three to four miles.

It is obvious that an improvement of the erosion situation must include the following measures; stopping the major part of the leakage through the moles which is res-

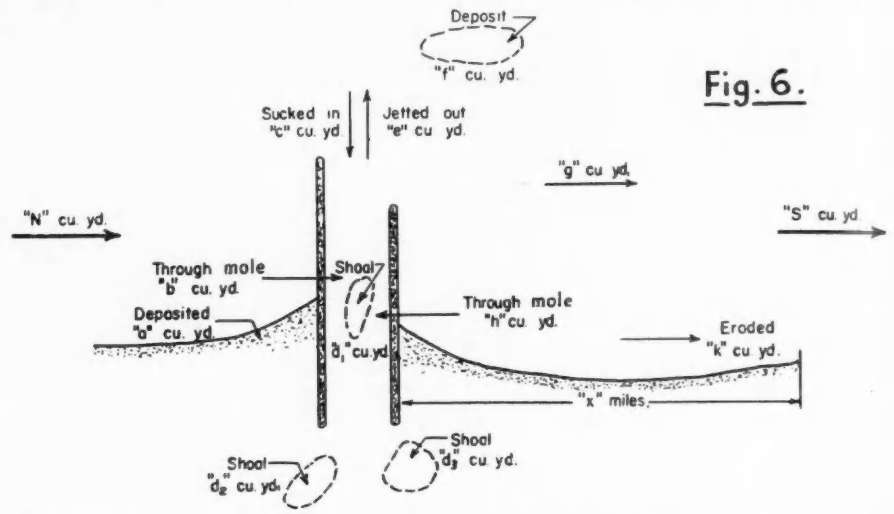


Fig. 6.

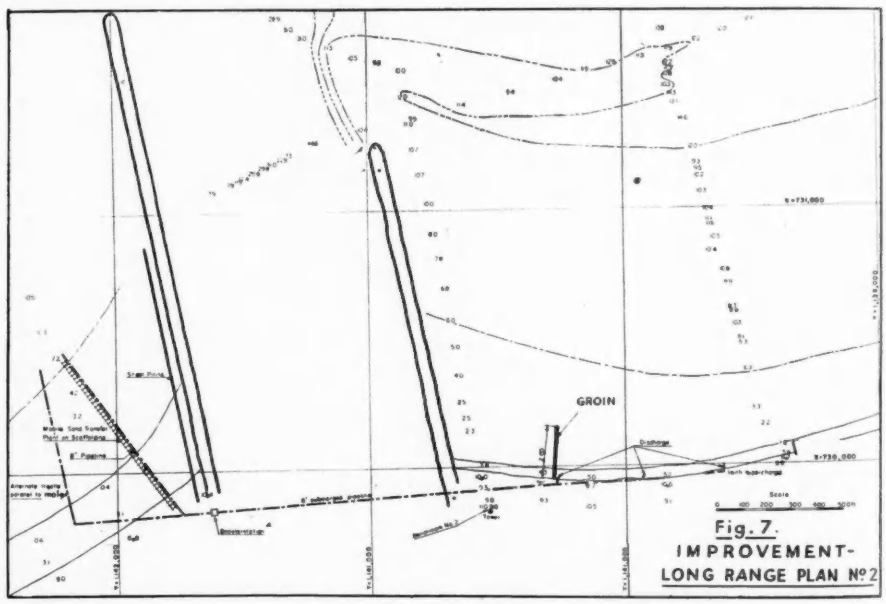


Fig. 7.
IMPROVEMENT-
LONG RANGE PLAN No 2

Conclusions

The Fort Pierce inlet acts as a partial littoral barrier for the normal longshore littoral drift which is predominantly southward in the net amount of over 200,000 cu. yds. per year.

The total amount of material lost because of the inlet's interference with the natural longshore littoral drift seems to be distributed as follows:—

Deposited against face of north mole, 20,000 cu. yds.; Lost by dredging or on bay shoals, 40,000 cu. yds:; Lost by inlet ebb current to deep water, 40,000 cu.yds.;

ponsible for a loss of about 80,000 cu. yds. of material per year, and at the same time transferring sand across the inlet from north to south; and, or, establishing artificial nourishment from the bay to the beach south of the inlet.

The amount of material to be transferred after tightening of the porosity of the north mole will probably be about 150,000 cu. yds. per year. As explained already it is necessary to nourish the beach south of the inlet as soon as possible. This can only be accomplished by pumping sand from the bay across the barrier and dumping it on

the beach. The alternative to this is to pump the sand from the beach north of the north mole it is assumed to use as its migratory path along the beach, and make the passage over, or on, or under, the inlet channel.

To render the rubble mole sand-tight one immediately thinks of sealing with concrete, sealing with asphalt bitumen, or with a curtain wall of sheet piling, all of them costly and of doubtful efficiency. The simplest solution would be to construct a wall of steel sheeting along the north toe of the north mole, treating it as an impermeable bulkhead.

The most suitable source of the backfill required for nourishment would be somewhere north of this bulkhead. To make full use of an ample area of beach would require a mobile suction head pump running along a light jetty from above high water to minus 6-ft. contour and retractable during storms.

The installation should consist of an 8-in. diameter dredge of 80 cu. yds. capacity per hour, requiring an 8-in. diameter pipeline and working 1,500 to 2,000 hours per year. In one single shift with such equipment the maximum operation time would be approximately 48 hours.

To avoid the various difficulties in the crossing of the inlet channel above water it would be advisable to bury the pipes in the channel bed, digging a trench for this purpose. This too has its difficulties but can be surmounted. The clogging up of a pipe due to stoppage of pumping is perhaps the most frequent. The existing plant at Palm Beach of 225,000 cu. yds. capacity has this arrangement of security.

The sand would have to be pumped about 3,000-ft and the maximum distance for the 8-in. pipe without supercharger is 2,000-ft. A booster pump would therefore be required also. There would have to be three discharge outlets arranged as shown in fig. 7 and at not less than 400-ft. from the south mole a 200-ft. length of groin would have to be constructed to prevent scour effect.

Protection against over wash of the barriers at storm and high tides could be effected by raising the present dune area, leaving a dike or embankment 20-ft. wide at crown and crown level at plus 15-ft. above mean low water at 400-ft. from shoreline.

Chamber of Shipping Annual Report

Nuclear Power, Tonnage Measurement, Ship Documentation and Kindred Subjects

The Chamber of Shipping's report for 1959-60, presented at the annual meeting on February 25th, deals with a number of matters of interest to dock and harbour authorities. Inevitably, nuclear power, both in relation to marine propulsion and to the carriage of radioactive materials by sea, comes in for attention. As for the former, the conclusion is reached that, in the present state of knowledge, it appears that only for very large ships, with over 20,000 s.h.p. and with a very high proportion of their operational life spent at sea—e.g., passenger ships and tankers—is there a foreseeable prospect of nuclear fuel being even nearly competitive with conventional means of propulsion.

With regard to the transport of radioactive materials, the basis of the Nuclear Installations (Licensing and Insurance) Act of 1959 is that the sole and absolute liability for damage arising out of nuclear casualties in respect of the carriage of nuclear material between ports within the United Kingdom is cast on the operator of the nuclear installation in which the nuclear material was irradiated. The liability is to endure throughout any period of carriage of the nuclear waste and, so long as that carriage is by a British ship between ports within the United Kingdom, no liability falls upon any other person than the operator.

As a protection to the victims of any nuclear casualty, the operator is to be compulsorily insured in the sum of £5 million. Any claim arising out of this liability must be brought, as a general rule, within ten years of the date of the occurrence, although in exceptional circumstances it could be brought within thirty years, on consideration by Parliament.

In the international sphere is has not, however, been found possible as yet to settle a draft convention, although much work has been done by the Organisation for European Economic Cooperation (O.E.E.C.), by the International Atomic Energy Agency, by the Comité Maritime International and by the British Maritime Law Association.

Apart from preparation for the forthcoming Safety Conference, on the first major tasks upon which the Inter-governmental Maritime Consultative Organisation (I.M.C.O.) has embarked is work on the revision of tonnage measurement requirements. In readiness for the first meeting of the sub-committee dealing with this subject, the chamber reconstituted its Tonnage Measurement Committee and, in concert with the Ministry of Transport, carried out detailed consultation with all members on the various aspects of this highly technical subject. A large measure of unanimity was disclosed by the replies received from members to the questionnaire circulated and this enabled the Tonnage Measurement Committee, in agreement with the representatives of the Liverpool Steam Ship Owners' Association, to submit to the Minstry of Transport a detailed memorandum which provided the basis of the submissions made by the United Kingdom delegates at the first meeting of the I.M.C.O. sub-committee in June.

At this meeting agreement was reached on the initial work programme of the sub-committee, including acceptance of a recommendation presented by the French delegates for establishing as complete a list as possible of the uses to which tonnage measurement is put in all fields by all countries represented on the sub-committee. Four experts, including the United Kingdom principal surveyor of tonnage, were nominated to assist the secretariat of I.M.C.O. in preparing the documentation for the next meeting, the date of which will depend upon the progress made by these experts, and will probably not be until after the Safety Conference.

Ship documentation has been a matter of concern to shipowners for many years past and many attempts have been made to secure simplification, both with regard to passenger manifests and what are known popularly as "ship's papers." In the case of passenger manifests, the report says that unfortunately the forecast made in the previous annual report of an early and satisfactory conclusion to discusssions extending over many years on this subject has not been fulfilled. Progress towards the introduction of a simplified form of passenger manifest—slow as it was—was interrupted by the changes of administration following the General Election. Pressure on the departments concerned has, however, been maintained at the highest level and, from assurances that have been given it is anticipated that the simplified procedure will be brought into operation at an early date.

The object of the simplified document is to relieve the passenger lines of a considerable burden of clerical work and of the necessity to interrogate passengers at the time of booking and to put shipping on a basis of parity with air in this respect. The revised form agreed with the Ministry consists of a simple nominal roll of passengers with their nationalities. The more detailed information still required for statistical purposes will be obtained from passengers during the course of the voyage, by asking them to complete cards. In the meantime, as recently as May, 1959 (the report comments) the air lines were relieved of the obligation,

which in their case was non-statutory, to provide even a simple nominal roll. Even if complete parity with air cannot be obtained at once, this will remain the ultimate objective.

The British Liner Committee examined Swedish proposals submitted to the Economic Commission for Europe for the standardisation of export documents. Only two of the forms comprised in the Swedish proposal were of direct concern to shipowners, i.e., the bill of lading and mates receipt. The Ministry of Transport was advised that the subject was not appropriate for governmental study and in the view of the committee should be left in the hands of commercial interests. It was also pointed out that there appeared to be no demand from traders to justify the extensive research required to standardise the documents proposed.

When its was learnt from the Ministry of Transport that I.M.C.O. was contemplating a study of the problem of simplifying or reducing the number of documents required for a ship when entering or leaving port, the Ministry was advised that in the committee's view, I.M.C.O. should only concern itself with governmental documents and not those of a commercial nature.

The International Chamber of Shipping has also a sub-committee on shipping documentation, which is "exploring the possibilities of reducing and simplifying documents required of shipowners." It is hoped that the work of the committee will encourage national studies, in addition to those already initiated in the United States and the European countries, with a view to achieving international recommendations to governments.

Another subject of practical importance which has come under discussion is the growth of the use of containers in sea transport and the international character of the matters which arise as a consequence. The establishment of an expert sub-committee to study and co-ordinate developments in this direction is under consideration.

New Zealand Waterfront Industry

Annual Report of Commission for 1958

The New Zealand Waterfront Industry Commission recently issued their report for 1958 on labour conditions in the ports of the country. Cargo handled during the year totalled 11,104,298 tons compared with 11,344,746 tons in 1957, a reduction of 240,448 tons. Oversea exports were 304,438 tons lower, which included a reduction in imports of bulk motor spirit, etc., of about 150,000 tons. Oversea exports increased by 53,996 tons and coastal cargoes increased by 61,248 tons.

The increase in exports and coastal cargoes partly offset the reduction in volume of oversea imports. While the overall employment position on the waterfront was not seriously affected there were some slack periods, particularly at the main ports. Trade through Auckland was also affected by the opening of Opua to oversea shipping and the increase in trade through Tauranga. A reduction of 220 registered workers compared with 1957 and increases in guaranteed wage payments granted in January, 1958, also assisted in maintaining the average hours and wages compared with 1957. The average weekly hours were 45½ compared with 45¾ in 1957 and wages were reduced by only 1s. from £20 12s. in 1957 to £20 11s. in 1958.

Rates of work and turn-round of shipping were maintained at the 1957 level and the workers continue to earn substantial bonuses under their co-operative contracting system. While the total amount of bonus paid out was reduced from £1,058,129 in 1957 to £1,025,351 in 1958 the average rate per paid hour increased from 1s. 10.9d. in 1957 to 1s. 10.25d. in 1958. Payments made under employers' incentive schemes increased from £51,709 in 1957 to £54,708 in 1958.

There were three stoppages of work in 1958, involving a loss of 26,929 man-hours as compared with the total paid hours of 15,150,604, a loss of 0.18 per cent of total man-hours. Two stoppages occurred at Auckland, both resulting from the decision of the Waterfront Industry Tribunal to grant exemption to the Colonial Sugar Refinery Company, Ltd., from the employment of waterside workers in the discharge of bulk sugar at Chelsea. As a protest against the Tribunal's decision the men decided to cease work on Friday and Saturday, July 4 and 5, 1958. Similar action was taken in October, 1957, in connection with a dispute over the "Ceramic." "Stoppages of work of this nature cannot be justified and are breaches of the written undertakings given by each worker to accept conciliation and arbitration in the settlement of disputes," the report comments. The other stoppage of work at Auckland was due to an unauthorised extension of the monthly stop-work meeting held on July 10, 1958, to discuss the bulk sugar dispute.

The dispute at Lyttelton arose through the refusal of men employed in the "Kaitoke" on August 20, 1958, to discharge hardwood poles into railway wagons on the inside line, notwithstanding that the gear inspector considered this method safe provided certain safeguards were carried out, which the employers agreed to. The men still considered the discharge of poles into wagons on the inside line was unsafe and referred to a serious accident which had previously occurred when work was carried out in this manner. The men considered that the wagons should be moved to the outside line and pointed out that the ship's gear could work the outside line. The dispute was settled by discharging the poles by crane to the outside line and agreement was subsequently reached between the employer and union that this method would be used in future, provided that where cranes are not available or where the ship's gear cannot plumb the outside line or where for some other reason it is not practicable to work the outside line, the inside line could be used. Having regard to the decision of the Chief Justice in the "Mount Park" dispute in Auckland in 1948, when he stated that where reasonable waterside workers considered a particular method of working was unsafe they were justified in ceasing work, the employer could have made this agreement with the union at the time the dispute arose and thus avoided the stoppage of work.

During the year the time lost through absence on compensation was 320,016 man-hours as compared with the 26,929 man-hours lost through industrial disputes. At December 31, 1958, there were 6,156 men on the bureau registers at main and secondary ports and during the year 1,545 men, or 25 per cent, were absent on compensation through accidents. Some of these men were absent for more than one accident. The time lost through accidents represented a loss of 52 man-hours, or approximately seven days for each registered worker in the industry. "This cost is much too high, whether measured by personal suffering of the insured, the lost time to the industry, the loss of wages to the workers, or the financial cost to the employers," the Commission state.

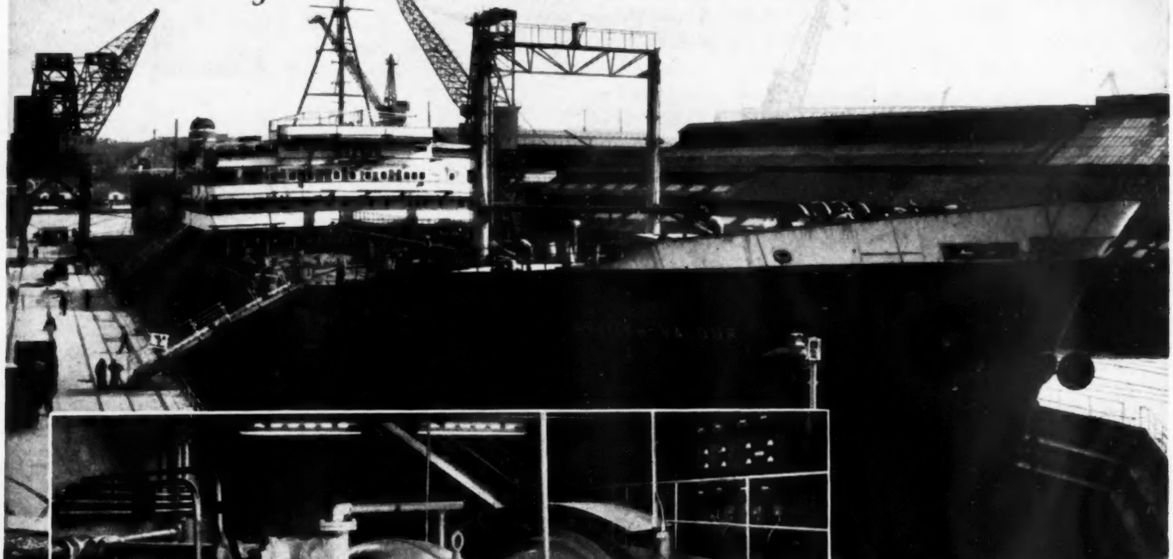
I.C.H.C.A. Conference

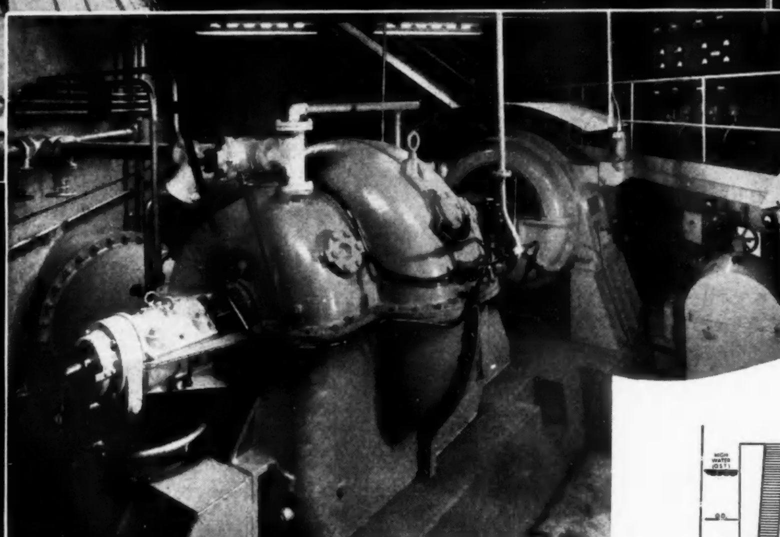
It is announced that, at the invitation of the Italian National Committee, the International Cargo Handling Co-ordination Association will hold a Technical Conference in Genoa in September this year. The subjects for discussion are: (1) The use of mechanical handling equipment on board ship and on the quay, and (2) Systems and equipment for the loading, maritime transport and unloading of motor cars.

Full details of the meeting will be issued at a later date, but as is customary, the conference is open to non-members of I.C.H.C.A. as well as members, and a cordial invitation is extended to all those interested in attending.

DRYSDALE PUMPS

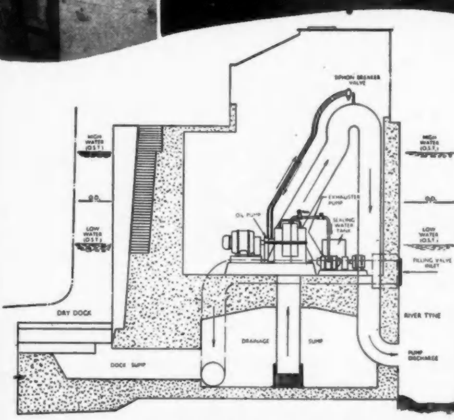
for Marine and Land Services





"British Valour" the new 32,000 tons B.P. tanker, built by Swan Hunter and Wigham Richardson, and the first ship to enter their new No. 4 Wallsend dry dock, is equipped with Drysdale pumps for cargo handling, main circulating, fire and bilge, oil fuel transfer, forced lubrication, etc.

No. 4 Wallsend dry dock takes tankers and passenger liners up to 45,000 tons and is de-watered by two Drysdale 48" centrifugal pumps which empty the dock of 16,000,000 gallons of water in $2\frac{1}{2}$ hours. The pumps operate with the Drysdale Anti-Syphonic Valveless System which provides high efficiency with low installation and maintenance costs.



Layout of Drysdale Anti-Syphonic Pumping System for Dry Docks.

Illustrations by courtesy of
B.P. Tanker Co. Ltd. and Swan Hunter & Wigham Richardson Ltd.

DRYSDALE & CO., LTD., YOKER, GLASGOW

Pumping Plant for Dry Docks

A Survey of a Modern System

By JAMES GRIEVE, A.M.I.Mech.E.

The following article is mainly a resumé on pumping plant as installed in Dry Docks, built in the United Kingdom and Western Europe subsequent to the 1939/1945 world war. Again, the details are of necessity confined to these docks with which the Author was directly concerned, with particular reference to the Drysdale patent system of Syphonic (or Anti Syphonic) pumping.

Dry Docks, by nature of their construction, are essentially expensive investments, and further the cost is naturally commensorate with the size of the excavation; therefore, the dimensions are related to the dimensions of the ships plying their trade in the vicinity of the dock, and also the dimensions must be related to the trend in dimensions of ships building or proposed.

Much thought has gone into the question of hull cleaning and painting of ships, and to the replacing of corroded or damaged parts below the water line. In ancient times this was done by "Careening", which could be managed relatively easily in the days of sailing ships. This was accomplished by removing everything from the ship which could be removed, hauling the ship inshore as far as possible at high tide, and carrying out the necessary work on a falling tide and at low tide. Naturally work had to stop at subsequent high tides, and restart at the next low tide, and a major overhaul would take some considerable time to carry out.

As sailing ships increased in however, this method proved uneconomic and with increasing trade, and a constantly increasing or improving standard of living throughout Britain, a quicker methor of ship repair was resolved by the building of dry docks in waters with a tide range sufficient to allow ships to sail in at high tide, and allow the dock to empty by gravity during the subsequent falling tide.

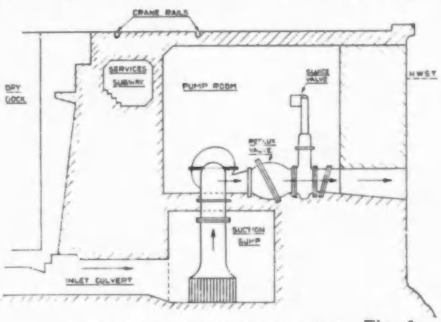
Ships continued to increase in size, especially after the introduction of the iron ship and the invention of the steam engine, and with the advent of the steam pump, docks could be constructed with the dock bottom lower than the level of low tide so that after docking, the gate could be closed and the dock pumped out at a quicker rate than the falling tide. Docks could also be constructed in almost tideless seas, such as the Mediterranean, and by pumping out after docking ships could be repaired there. Dry Docks on the Island of Malta are an example of this design.

So much for the brief history of docking requirements.

As regards pumping plant, the first dry docks, as far as can be ascertained, were owned by the British Admiralty, and the pumping plant consisted of massive steam engines, and large reciprocating pumps with the usual range of boilers, steam lines, stokers, coal handlers, etc.

Such massive and costly plant, which was also expensive to run, eventually became uneconomic and, as wages increased and prices of material and fuel also increased, a more economic method of dry dock dewatering was sought.

The advent of the centrifugal pump at the beginning of the present century provided part of the answer by being coupled to the high speed steam engine, and while the centrifugal pump of these days was less efficient than a modern centrifugal pump, the improved steam consumption of the high speed steam engine did help to reduce running costs.



DIAGRAMMATIC ARRANGEMENT - VALVE PUMPING SYSTEM Fig. 1

In many shipbuilding and ship repairing establishments ships are handled in Floating Dry Docks, which also are dependent on pumping for submergence and elevation, but as the treatment dealing with the design of such Docks is entirely different, they are deliberately left out of this article.

The present day answer however is in the introduction of the Electric Motor. This eliminates entirely all need for Boiler plant with its train of stokers, coal handlers, etc., and further the high speed of the electric motor enabled the centrifugal pump to be reduced in size relative to its output, thus allowing larger capacity pumps to be installed in a relatively small space and so reducing the time required for dewatering the dock, with the same capital outlay.

In dry docking a vessel, time can be regarded as the essence of the operation, due to the considerable number of highly skilled (and highly paid) artisans, standing by during this operation. Centrifugal pumps therefore are peculiarly appropriate in combination with the dry dock by virtue of the fact that the characteristics of such pumps match in with the requirement of discharging from the dock the greatest quantity of water in the shortest possible time; e.g. the centrifugal pump discharges a greatly increased output at very low heads as at the beginning of pumping out a dock where the static head is nil, only the system friction is present. This peculiarity can be seen in the paragraph dealing with pump characteristics.

In addition to the above advantage there is the further fact that by correct hydraulic design the centrifugal pump can be made to utilize approximately the full power of the driving motor over the full range of the pumping head while dewatering the dock.

An inherent disadvantage of the centrifugal pump is its inability to prime itself, and at first it was thought that the pumps would require to be placed in a house below the lowest level of the dock. With the introduction of the steam ejector however, these plants driven by high speed steam engines, could be placed in a position well above the dock bottom, and when the necessity arose to stop the pumps with the water level in the dock below them, they could be primed by the steam ejectors, and restarted with a suction lift obtaining in their working conditions of lift.

Today large electrically driven pumps are generally placed with the pump house floor level about 12/14-ft. above dock bottom and electrically operated air pumps provide the means of priming, should it be required to stop the main pumps with the water level below the pumps. This quite frequently happens due to requirements of hull cleaning while the dock is being emptied.

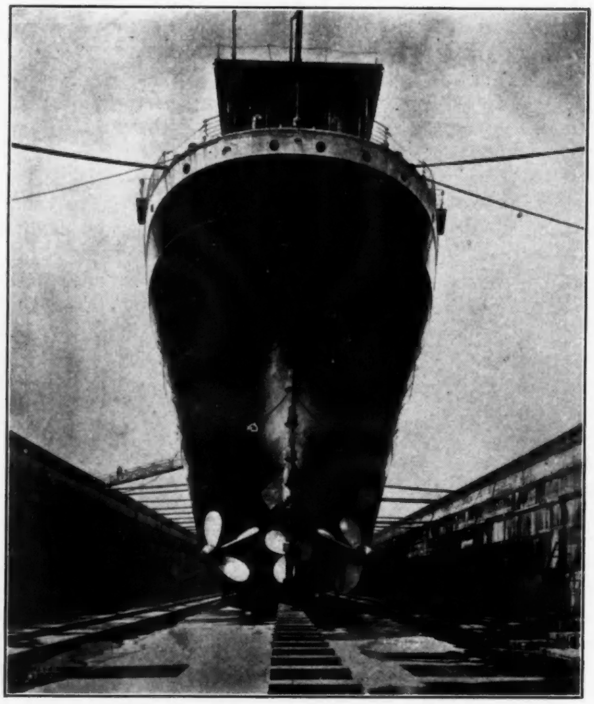
Fig. (1) shows diagrammatically the almost universal arrangement of centrifugal pumping plant in a dry dock, and as pumping commences with the water in the dry dock at the same level as the sea or river outside, it will be obvious that the pump is adequately primed at the start of pumping. It will also be obvious that should pumping be stopped while the water in the dock is below the level of the pump centre line, priming must be resorted to, before pumping can be restarted.

It might be argued that a footvalve at the bottom of the main pump suction pipe

could eliminate the necessity for priming by keeping the suction pipe and pump full of water ready for starting up while hull cleaning is being carried out. However, the presence of a very considerable quantity of debris, such as floating wood, pieces of rope, rags and waste, make the successful operation of a footvalve a very questionable proposition. It has been found by bitter experience that such debris always finds its way into footvalve and prevents it from closing properly, so that it becomes no more than an expensive piece of furniture of very little (if any) use. It would also be an expensive operation to have a diver go down and examine the valve or clean it out every time it jammed open, hence the reason they are never fitted nowadays.

With regard to the size of dry docks, as mentioned earlier, these have had to keep pace with the increase in ship dimensions, and while older docks vary in size from 250-ft. up to 500/600-ft. in length, with widths up to 65/70-ft. in the larger sizes, these still are suitable for docking ships of an older design, and still have many years of useful life before them.

With the advent of post war ship design however, including especially the new oil tankers, most of the older docks proved unsuitable owing to the much increased beam/length ratio of these larger types of ships. For example, the latest 32,000 ton tankers are 640-ft. long x 85-ft. beam, and the 42,000 ton tankers 665-ft. long x 95-ft. beam, and while there are a number of docks capable of taking the smaller of these, the width of the larger is such that very few dry docks are available for them. In addition even larger tankers are under construction and as a result there have been a number of new dry docks built in the U.K., and others are contemplated, as well as the alteration and enlargement of existing docks. At present there are building in some parts of the world, tankers of 100,000 tons D.W. or thereabouts, and naturally dry docks will be a necessary adjunct to ships of this size in order to keep them operational for as long as possible.



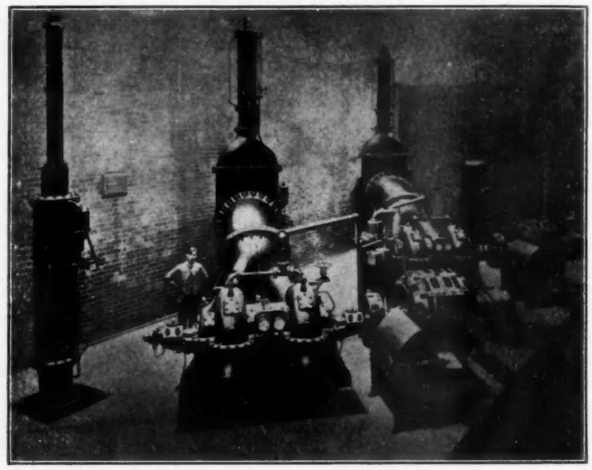


Fig. 2 (left)

Fig. 3 (right)

Fig. 2 is an illustration of King George V Dock, London with a ship in position for repair and hull cleaning. The pumping plant was supplied in the early 1920's. Fig. 3 shows the pump room of a similar dock from which it will be seen that the plant, while fully 30 years old, is quite modern as regards layout. This dock is 750-ft. long x 100-ft. wide, and is used mostly for docking large passenger liners. As already stated, however, the latest demand is for docking facilities for large tankers with their larger beam and for these to be sited near the oil terminals and building yards. Two further requirements for handling tankers are the provision of ballast pumping plant for tank testing and adequate fire fighting plant.

It is now proposed to deal with those docks which have been built since the year 1946.

The illustrations, figs. 1, 3, 4, 5, show the almost universal arrangement of pumping plant with each main pump having a Non-Return Valve and Sluice Valve on the delivery branch of each. These valves, of a size between 36-in. and 48-in. bore, for modern docks, are costly pieces of apparatus, and further, the maintenance charges are quite high, providing a constant standing annual charge which must be met in order to keep the dock in service. A further hazard relative to valves is the possibility of jamming in the closed position, and the writer had a personal reminder of this quite recently when the delivery sluice valve on a 36-in. dock dewatering pump did actually jam and defied all efforts to move the jammed wedge for more than a week. Eventually the valve makers had to be called in to free it and during this time the dock would have been out of commission entirely but for the fortunate fact that there were two main pumps so that the second could be used alone. Even so, this doubled the time of emptying the dock, with a consequent increase in costs and, even worse, owing to the heavy demand for docking facilities, the accident necessitated a revision of the docking programme.

The use on each main pump, of an hydraulically operated sluice valve only, eliminates the non-return valve. This is an ordinary wedge type sluice valve, but with an hydraulic cylinder on top fed with pressure oil from a force pump, (electrically driven). The starting up of the main pump is interlocked with the starter of the force pump, and when the main pump (or pumps) start up the force pump also starts up, providing pressure oil on the underside of the hydraulic piston and thus the sluice valve starts to open when the main pumps are up to speed.

When the main pumps are stopped, or should they stop for any reason (such as overload trips opening) then the force pump also stops and as this removes instantly the oil pressure from the hydraulic cylinder holding the valve open, and as dead weights are provided on an extension

of the valve rod, the sluice valve closes automatically, so performing the combined function of a sluice valve and non-return valve. However, the possibility of the sluice wedge jamming, as described above, is still there, and to this end, a pumping scheme for Dry Docks has been evolved and operated very successfully. This is known as the "Drysdale Syphonic Pumping System", and figs. 1 and 6 show the basic design features.

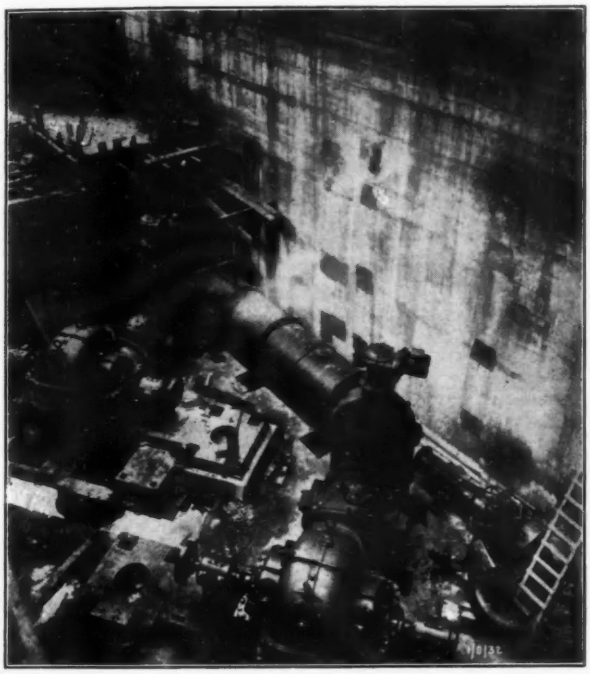


Fig. 4

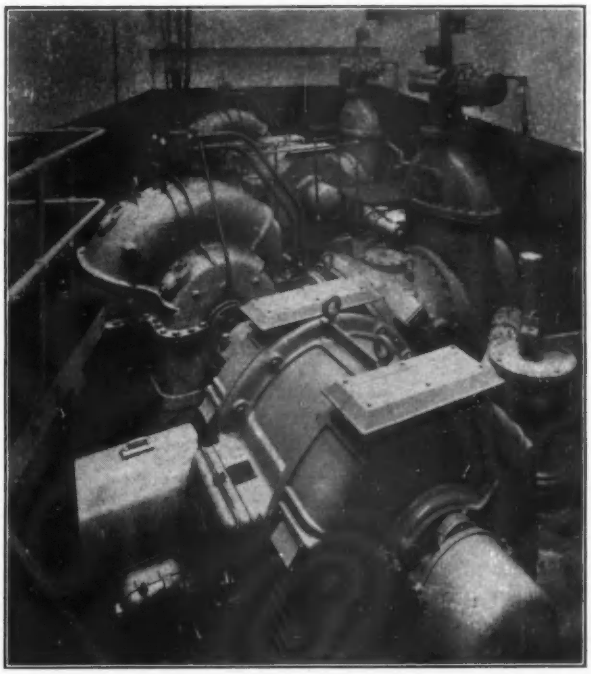
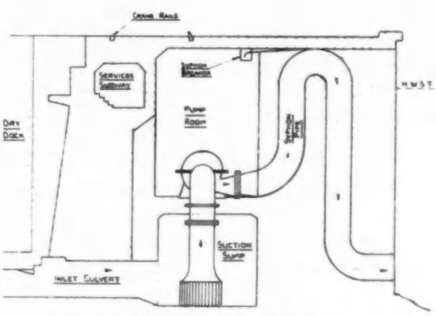


Fig. 5

The sluice and N.R. Valves are eliminated entirely and the pump delivers into a syphon pipe with the crest of the syphon 2/3-ft. above the highest spring tide recorded. As can be seen from the sketch, the width of the pump house is reduced to the smallest figure possible to house the pump, and further flooding of the pump sump is impossible due to the fitting of a syphon breaking valve at the top of the syphon so that when the pump is stopped, the syphon is broken, and it is not possible for back flow from the river into the dock.

There are many points in favour of this arrangement, and from actual installation and running experience the following are listed:—

1 The elimination of sluice and N.R. valves greatly reduces the cost of installation.
2 Arrangements for stop logs on the outlet end of the discharge column are not necessary, as there are no valves to be examined.
3 Water hammer is not possible due to unforseen stoppages, such as failure of electrical supply.
4 Hydraulic resistance is reduced by elimination of valves resulting in reduced power expenditure.
5 When pumping is stopped, there is a small back flow due to the water in the upwards leg of the syphon flowing back into the sump. This flushes any rubbish clinging to the strainer bars off into the sump.



Diagrammatic Arrangement – Syphon Pumping

Fig. 6

6 The time required in the opening of power operated valves is saved, the pumps going on to full load immediately on being started.
7 Flooding of the dock from the river or sea through the syphon pipe is impossible with the type of Syphon Breaking Valve used, also elimination of valves ensures that these cannot stick in the "open" position which could cause flooding of a dock.
8 Natural venting of the sump ensures freedom from hazards arising due to the presence of petroleum vapours, when repairing tankers.

As regards **Item (1)** it should be remembered that sluice valves and non-return valves of the size required viz: 36/48-in. come to many thousands of pounds in first cost, and the saving therefore is considerable, in addition the smaller size of pump house also reduces first cost.

Considering **Item (4)** the reduction in friction in the delivery line is admittedly small, in the region of 1-ft. or $1\frac{1}{2}$-ft. but it should be remembered that this forms quite an appreciable percentage of the total head figure: e.g. a dock of 715-ft. length will have a depth of water of about 33-ft. at highest tide.

When pumping starts, there will not be any static head, the level outside the dock being for all practicable purposes the same as inside. Therefore, the pumping head at start will be against the frictional loss in the system only. This is usually about 10-ft., and a saving of 1-ft. at this point is 10% of the total. The mean static head (at half dock) is 16.5-ft. and a saving of about $\frac{1}{2}$-ft. here is about $4\frac{1}{4}$%.

Such savings, taking into account the cost of current on a maximum demand basis can be of considerable magnitude when translated into costs.

Re Item (5). The amount of water contained in the leg of the syphon pipe is relatively small and this small amount flooding back into the dock sump will not

cause any inconvenience, but has the advantage that debris tending to cling to the strainer bars is washed off in the backwards flow.

Re Item (6). For large electrically operated sluice valves, the rate of opening and closing is approximately 1-ft. per minute and with a 48-in. valve the time would be 4 minutes which would be the time taken from starting up until the pump could go on full load. With the syphon system the pumps go on full load immediately on starting up.

Re Item (7). As mentioned above, flooding of the dock from the sea or river is not possible with the syphon pipe crests carried above the highest spring tide level. Reverse flow in the syphon pipe is not possible due to the design of the syphon breaking valve.

On starting up the main pumps the closing of the main switch automatically starts up an oil pressure pump motor (which hydraulically controls the automatic syphon breaker valve) and closes the vacuum breaker.

The water being discharged from the main pumps, flushes all air out of the syphon pipes, and, the vacuum breaker being closed, the establishment of the syphon is completed. During dewatering, syphonic assistance is in operation all the time, and the main pumps are required to deliver against a head of (a) static head between W.L. in the dock and W.L. in the river, (b) plus the friction in the pipe system.

On the main pumps being stopped by opening the main starter switch, the valve control oil pressure pump is also stopped, and the vacuum breaker valve opens immediately, allowing atmospheric air to enter and break the syphon, thus preventing reverse syphonic air to enter and break the syphon, thus preventing reverse syphonic flow from the river into the empty dock.

Again, should the syphon valves fail to close when the main pumps start up no harm will result except that the main pumps will require to work against the maximum head between the W.L. in the dock and the crest of the syphon all the time. This would slightly increase the time for dewatering the dock. It is a requisite of the overall design that the natural position of the air valve is the "open" position. Even if anything goes wrong with the functioning of the system the valve is still left in the "open" position, ensuring that a reverse syphonic flow (from river to dock) cannot occur.

Re Item (8). Due to the number of oil tankers with which the new docks will require to deal, there is a danger of inflammable liquids being drained out of such vessels while in dry dock, and naturally such liquids will drain into the pump house sump. The drainage pumps in the pump room will deal with all liquid in the sump, but gases will form and should they be ignited by a welding torch, an explosion could occur which might wreck the pumps, should they be fitted with valves, which naturally would be closed while a ship was in dock. With the syphon system, however, the open syphon breaking valves offer a path to atmosphere for the ignited and rapidly expanding gases, so that explosion pressures cannot arise, and the open air valves then form a further protection to the installation by acting as safety valves. Accidents of this kind have actually taken place with an explosion in the pump sump but with no harmful effects to the machinery.

Costs

It has been shown that the elimination of valves reduces the working head by a small amount, thus reducing electricity costs (admittedly by only a small percentage) and, further, the elmination of valves wipes out maintenance charges on these items (which can be considerable). The greatest saving however is in initial cost, due to the high prices required for these very large and special valves (between £3,000/£5,000 each). It has been argued that the cost of syphon pipes may be as great as the cost of valves. In practice, however, this has not been found to be the case, as the syphons can be formed in the pump house walls and, in addition, the syphons are built of pre-cast concrete pipes which can be obtained quickly, and at a reasonable price. Also the dimensions of the pump house can be reduced in width by the amount of space which would be required to accommodate the valves. From the foregoing it will be obvious that an all-round reduction in initial costs can be obtained by the elimination of valves and, in addition, a reduction in running costs is also effected.

Types of Pumps

The type of Pump most usual in dry dock installations is the horizontal spindle divided casing type, but personal preference can influence the choice and some vertical spindle divided casing pumps have also been used. Again the vertical spindle suspended axial flow type has been installed, because this type was dictated by the construction of a dock relative to other docks in the vicinity.

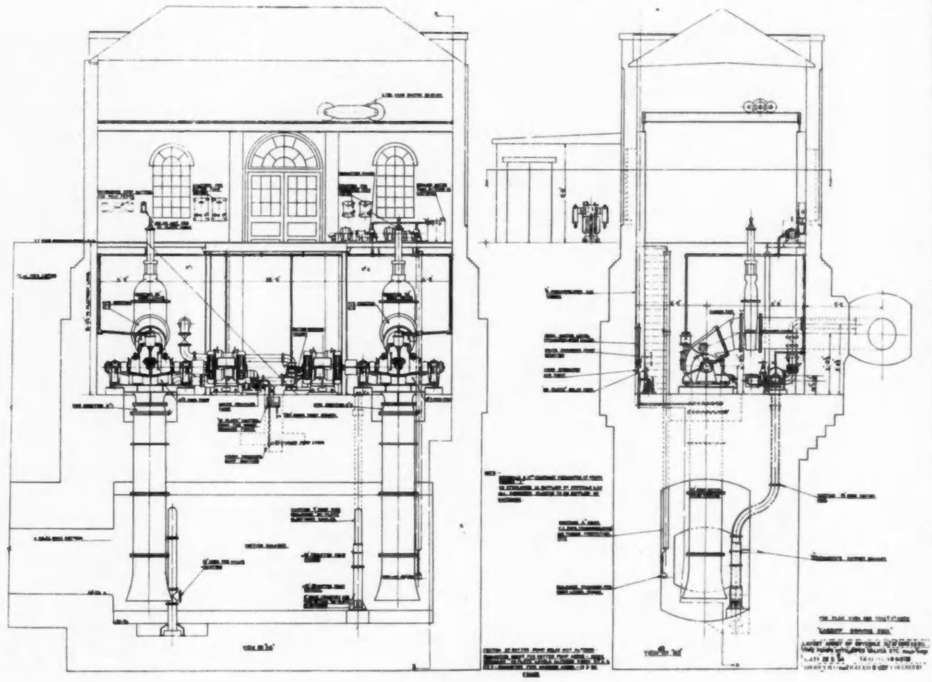


Fig. 7

The horizontal spindle divided casing pump is naturally the most popular type due to its high degree of accessibility, the cover being easily and quickly removable for internal inspection of the pump interior or the removal of the rotating element. All crane lifts are vertically upwards and no special slings or lifting gear is required.

Fig. 7 shows pumps of this type which were installed recently in a South Wales Dock which was being modernised. A requirement of this installation was the matching up of existing suction and delivery pipes which made it necessary to have the delivery branch on the top half of the pump casing. This necessitates the delivery pipe joint being broken and remade every time the pump is opened up for

examination. Further the syphonic design could not be used as this was an existing piping system.

Figs. 8 and 9 (Elevation and Plan View respectively) show the layout of the first Syphonic System Pumps installed (on the North East Coast of England). The main pumps are of the horizontal spindle divided casing type with the suction and delivery branches on the bottom half casing giving maximum accessibility. The smaller pumps (bilge and ballast) are of the upright vertical spindle type with the driving motors mounted dierctly on top of the pump casings. The vertical arrangement of the auxiliary pumps ensures minimum space occupation for these units. The three auxiliary pumps in this station were so arranged that one of the three was used for dock drainage only the other two being for ballast duty and tank testing on board the ship in the dock. One of the two ballast pumps can also be used as a dock drainage pump should it be necessary at any time to augment the drainage pump capacity due, say, to a damaged dock gate seal.

Another interesting feature of this installation was the necessity to devise a method for disposing of the silt which tended to gather at the dock gate and could prevent the gate being lowered to allow a ship to enter the dock. The two ballast pumps were arranged to run in parallel and deliver water through a 12-in. pipe which was connected to 24 nozzles at the bottom of the dock gate. The water (in the region of 4,000 G.P.M.) was at sufficient pressure to agitate the silt tending to gather there and by arrangement of the nozzles the silt was swept into the natural current of the river and dispersed.

The drawings show clearly the delivery syphon pipes and the syphon breaking valves at the top of these.

Figs. 10 and 11 (Elevation and Plan respectively) show plant for a dock of similar size to the above, but on this occasion the demand was for a pump house as small as possible. To achieve this the pumps are of the " Upright " Vertical Spindle type with the pipe joints made in the back half casing, allowing the front cover to be removed for internal inspection or removal of the rotating element. This can be done without breaking any pipe joints. The saving in space of this layout should be noted, and also the fact that the bilge and ballast pumps, two in number, can be used as two drainage pumps, or alternatively as two ballast pumps. Again the syphon pipes and syphon breaking valves can be very clearly seen on the drawing.

In this installation the consultants stipulated that the drainage (and ballast) pumps should be of the self priming type and that they should start by push button and stop automatically when the water level had been depressed to a predetermined low level in the sump.

An unusual layout for dock pumps is shown in Fig. 12, the position being somewhat cramped by having several docks side by side and leaving practically no room for a pumping station of the orthodox type. It was therefore decided to install vertical spindle axial flow pumps in each of two docks, the pumps being fitted in (virtually) vertical slots cut out of the dock sides. The electrical gear was housed in a watertight compartment under the cope level, the pumps draining the water from the dock bottom (as illustrated) and discharging direct to the river through a non-return valve.

As the seating for the motor stool acts also as a means of suspending the pump itself, this seating had to be made watertight with the result that the top part of the suspension pipe, the delivery pipe and also the non-return valve body had all to be grouted into this concrete plug.

To give access to the pump and N.R. valve the latter had an access door above the floor level of the motor room, and the pump itself was provided with access doors on the rising main so that access to the interior could be obtained. For examination of the interior of a pump such as this, the only way is to remove the pump bodily from the site. By means of the access doors on the rising main, access to a shaft coupling is obtained and by removing the flange bolts on the rising main the pump proper can be removed for overhaul when required, leaving the grouted-in parts on the site. As the Pump impeller is located below the dock bottom the question of priming does not arise, and an air pump is therefore not required.

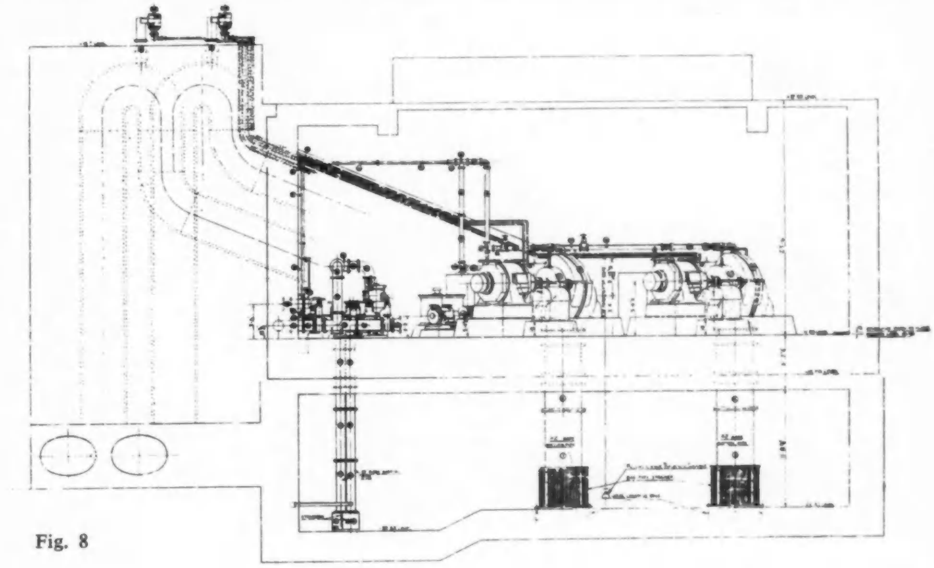


Fig. 8

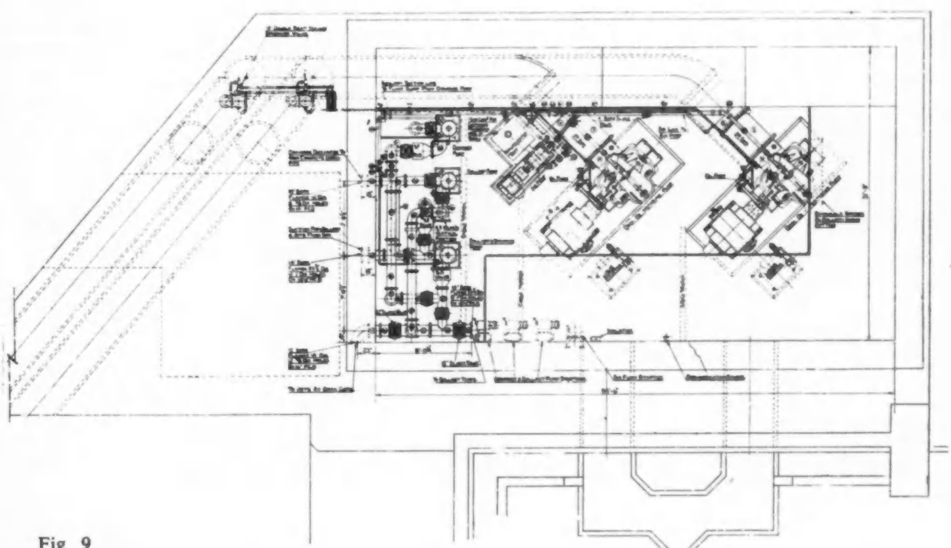


Fig 9

The question of sewage disposal in plant of this type does not generally arise, but it may be of interest to make a passing reference to this point in view of a very interesting installation carried out in Holland at a Dry Dock in Rotterdam. The main pumping machinery was of the Syphonic type (similar to the plant shown

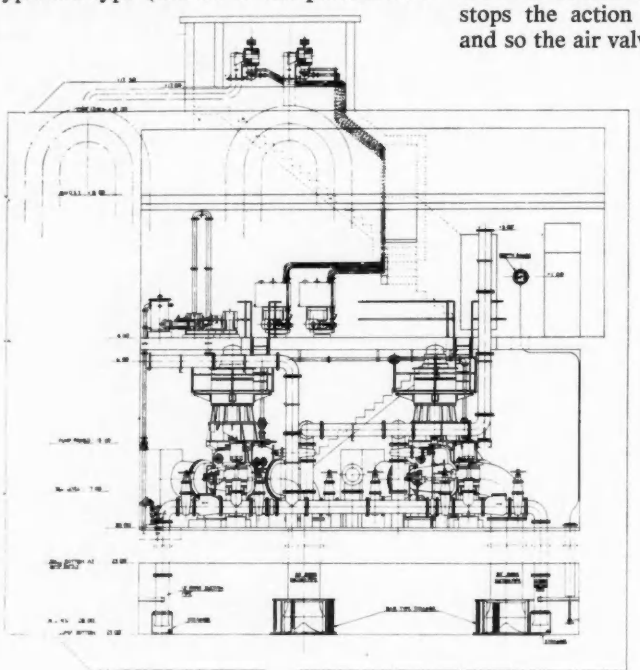


Fig. 10

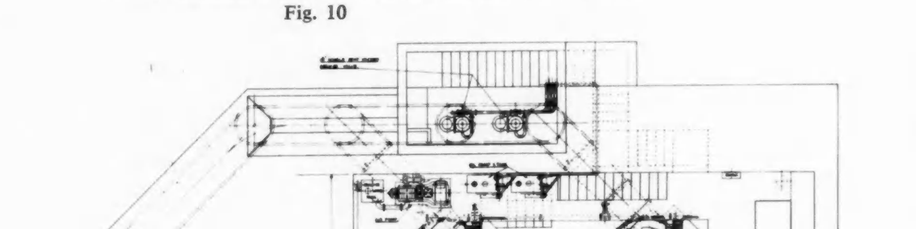


Fig. 11

on Fig. 8) with the addition of a sewage ejector as detailed on Fig. 13. The apparatus shown was fitted in a watertight compartment at the dock bottom. After docking, the ship's sewage system is connected to the inlet valve near the top of the receiver. When the sewage rises to a certain predetermined high level in the receiver, the upper float switch becomes actuated, energising the electric thrustor on top of the receiver. This thrustor opens a valve connected to a compressed air system, and by the air under pressure entering the receiver, the sewage is "compressed" out of the tank through the discharge valve on the receiver bottom into the town's sewage system. When the receiver reaches a predetermined low level the float switch at the low level acts, and stops the action of the electric thrustor, and so the air valve closes under the action of the dead weight shown, cutting off the supply of compressed air, and at the same time allowing the receiver to vent to atmosphere. Thereafter the cycle of events proceeds as above.

The above plant is not normally the business of dry dock Companies, but in view of recent legislation regarding purification of rivers, the remarks above may be considered timely and of interest.

Pump Characteristics.

The characteristics of any dock dewatering pump are of interest to both the buyer and manufacturer. To the buyer they are a proof that the plant offered will perform the functions claimed by the manufacturer, and to the latter they are an absolute necessity when making the calculations for determining the size of pump and power of driving motor required.

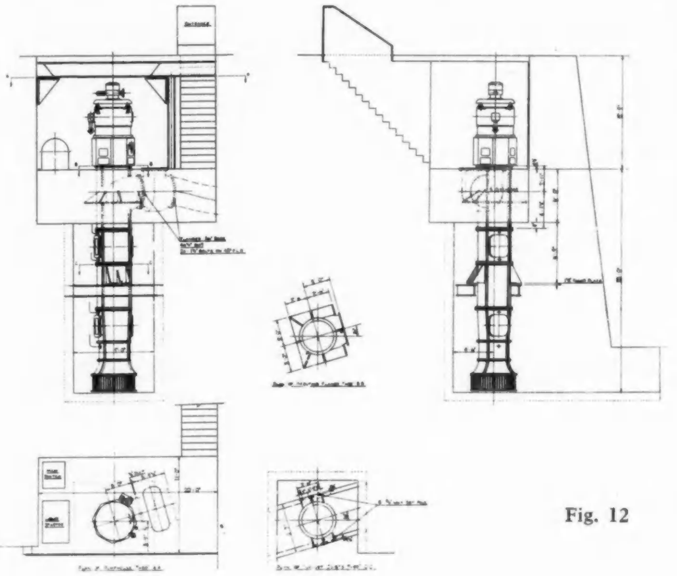


Fig. 12

To the manufacturer of the pumping plant the data needed is as follows:—

(a) Length of Dock.
(b) Cross Section of Dock.
(c) Cope level of Dock.
(d) Depth to bottom of Dock.
(e) Level of H.W.O.S.T. (high water ordinary spring tide).
(f) Level of L.W.O.S.T. (low water ordinary spring tide).
(g) Level of H.W.O.N.T. (high water ordinary neap tide).
(h) Level of L.W.O.N.T. (low water ordinary neap tide).
(j) Time required for dewatering.
(k) Cubic capacity of Dock at H.W.O.S.T. (generally in cubic feet).

This latter figure (k) is always the capacity of a full dock **without** a ship in it, and the usual guarantee asked is that the dock shall be emptied of this amount of water down to dock bottom in a given time (generally 2 to 3 hours).

By laborious calculation the engineer preparing the scheme arrives at a mean capacity, at a mean head. He then selects a pump of the size required and draws a characteristic curve as shown on Fig. 14. This shows clearly the capacity of the pump at all head conditions occurring during emptying of the dock. The steepness

of the pump characteristic is very necessary for this type of work in order that the variation in capacity may be kept to a minimum. The ideal characteristic would of course, be a vertical straight line giving a constant quantity irrespective of head, but this is not possible with a centrifugal pump. It should also be noted that the power characteristic is of the non overloading type, such that no matter what head condition is required the power of the driving motor can never be exceeded. In this particular case the driving motor was rated at 650 h.p. at 365 r.p.m. and from the curve the maximum power absorbed never exceeds 600 h.p.

A further characteristic curve will now be considered, this being in relation to the Axial Flow Type of Pump, as described previously, and as shown in Fig. 12. Curves applicable to this type of pump are shown in Fig. 15, and while this type of unit has an exceedingly useful capacity characteristic due to its steepness, giving a minimum variation of capacity from dock full to dock empty, there is one disadvantage viz: the rising H.P. curve. This is a considerable disadvantage in pumping schemes where valves are employed, as if the pump is inadvertently left running with the delivery sluice valve closed, a burned out motor could result, due to the fact that at valve shut this type of pump takes almost double the power required at normal duty. It would be very uneconomic to fit a motor to suit the valve shut condition and would result in poor motor efficiency and power factor when running at the more normal working condition.

To use this type of pump therefore it is usual to fit only a non return valve for normal service, the sluice valve (when fitted) being used only for isolating purposes when it is desired to open up the pump.

Another disadvantage of the axial flow type pump of the suspended type is its comparative inaccessibility. It is expensive and troublesome to open up a pump of this type as will be seen by reference to Fig. 12; hence the reason for the fact that, up to date, they have not been looked upon with favour by dry dock owners. However, provided they are not used with a closed delivery valve, the writer feels that there may be a future for them in dry dock work, especially with the syphonic system, where a closed delivery valve cannot occur, and provided that dry dock owners and operators are prepared to stand the comparatively high charges incidental to opening up operations. In so far as initial cost is concerned, this is slightly in favour of the axial flow pump, but actually there is not much in it either way as the reduction in cost of pump house due to the smaller size and higher speed motor, is offset by the fact that the suspension main and shafting are more expensive in the axial flow than in the centrifugal type pump.

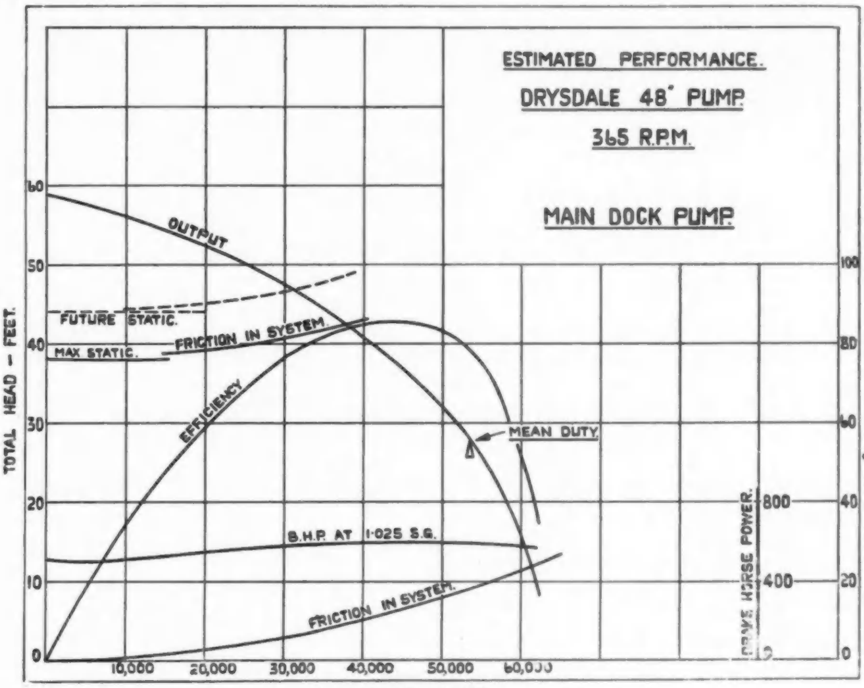


Fig. 14

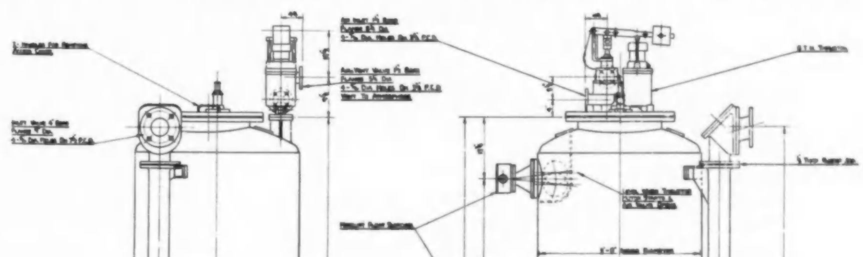


Fig. 13

General Remarks.

There is a further point which is worth investigating, viz:— the method of drive. In most cases this is by electric motor but taking the method of charging for electric current, on a "maximum demand" basis, it seems there may be a case for the diesel engine being considered as the driving unit for the main pumps. It must be remembered that pumping out a dock may take place not much more than twice per week or say 8 times per month. Say the time taken to pump out is 2 hours, this is only a total of 16 hours per month, and with the "maximum demand" method of payment, the consumer, instead of paying a flat rate per unit of electricity used, pays only a small rate per unit, but also pays a high rate per unit in addition, based on the maximum power consumed for a stipulated period (say 2 hours per month). Now a dock Company may be using only 1,000 units of electricity per month, for ordinary

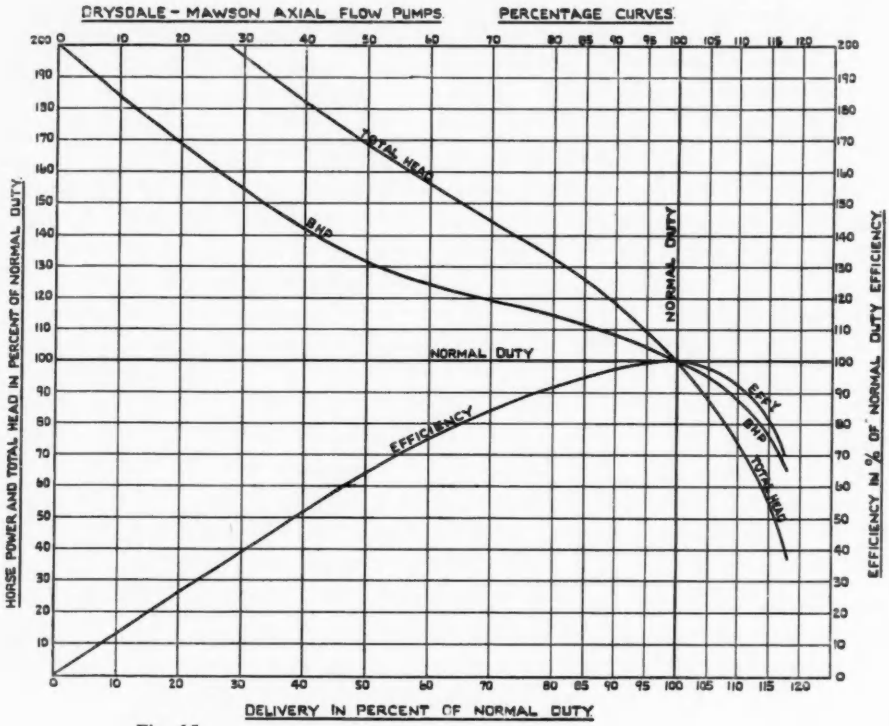


Fig. 15

services at the rate of say 50 units per day. The "maximum demand" meter will therefore record only the maximum requirement for any period (say a maximum of 50 units). Suppose however, the dock pump motors together take 800 units per hour for the two hour pumping period, then the "maximum demand" meter will record this 800 unit requirement, and the dock company will then be required to pay the high rate extra on this figure, even although the dock was pumped out only once in any particular month.

The charge may be as much as 10/- up to 15/- per unit of electricity on "maximum demand", and it will be realised that the electricity costs for pumping are very heavy. It must be borne in mind however that this charge must not be thought excessive as it is necessary to pay for:—

(a) Current supplied.

(b) Cost of installing Cables, Transformers and Meters.

(c) Maintenance of items listed in (b).

(d) Generating plant at power station must be of sufficient capacity to supply full power at any time of day or night.

Some dock companies therefore instal their own power generating plant, but for small companies it would seem that diesel engine drive for the main pumps would be an economic proposition, as with such engines, there is only cost of fuel oil to budget for, thus cutting down a heavy monthly charge for electricity. Maintenance of diesel engines may be slightly more costly than electrical gear, (although this point is debatable), and the initial cost is not greatly different, therefore the cost of running the diesel engines should show a considerable saving. A further point in favour of the diesel drive is the freedom from stoppage due to power cuts, or interference with supply.

The Writer would thank Messrs. Drysdale and Co. Ltd., Glasgow, for their kind permission to publish the above and for the access granted to records and illustrations.

Correspondence

To The Editor of the Dock and Harbour Authority

Sir,

May we make a few very mild comments upon the Editorial in your January issue, concerning the Debate on inland waterways in the House of Commons on 4th December?

The most remarkable feature of the Debate was the virtual unanimity of the speakers, from both sides of the House, in calling for a National Waterways Conservancy; and it simply is not true that "many" of them "admitted that they were using the same brief". A single speaker made a facetious remark to that effect, but, in fact, the arguments advanced were very varied, and, on the other hand, it is not remarkable that some of them coincided. When people feel strongly about a subject, they naturally tend to have been influenced by the same arguments. Many of the speakers were also extremely critical of British Waterways. Mr. Geoffrey Wilson, no mean authority, said (Column 1574 in Hansard): "If we look at the Report and Accounts of British Waterways for 1958, we find that they made a loss of £640,000. Receipts were slightly higher, but the loss was double what it was in the previous year. Costs of administration went up by 20 per cent. The numbers of administrative and clerical staff increased by 8 per cent. Nearly a quarter of the entire staff left, and had to be replaced during the year. There may be reasonable explanations of all that, but if the Commission were a private or public liability company, I think the chairman would have to do a lot of explaining at the Annual General Meeting as to how it came about."

The Commission may be "committed to ensure that the railways are profitable", but few indeed are they who believe that this commitment will, or can, be met. The future, if any, of public transport in Great Britain lies in what is miscalled a subsidy; properly, in taking steps to level up the enormous advantage accruing to road transport from the vast historical investment in existing highways. As far as the waterways are concerned, it is not a case of "generalised claims" that they are inherently cheap; but of pointing out the great variety of advantages that would derive from their rehabilitation and efficient management.

If the whole system were properly exploited in all its functions, it well might pay at an early date; which is more than can be said for the railways. It is lacking in vision, for example, to speak of "a small sectional interest of pleasure-boat users". It is well known that if one seeks a growth investment, one looks for a line of business that is prospering in the United States, but not yet prospering to the same extent here. It would be difficult to think of a better case in any field than that presented by pleasure boating. As long ago as 1957, there were in the United States 7,071,000 pleasure boats. 35,000,000 men, women, and children "participated in boating", according to "The New York Times", which states that "unmistakeably recreational boating is the nation's top family sport". On this sport, $1,912,000,000 was spent at the retail level.

Similarly with water supply. The demand is great, and is rising each year by leaps and bounds. If the tangle of obsolete

statutes governing the sale of water, could be unravelled, the revenue could be enormous.

Even angling is an important business consideration. If every known angler on the nationalised waterways were to pay a special annual levy of half a crown, the total realised would by itself dispose of the deficit on the whole system brought out in the Commission's Board of Survey Report.

The need is to vest all the waterways in an authority which would go with vigour after all the different uses and potentialities. As today it has been repeatedly shown that it often costs more to close a navigation than to restore and use it, there is really no argument against the National Waterways Conservancy. Under this body, the income from non-transport sources might well suffice modestly to " subsidise " transport.

Your faithfully,
ROBERT AICKMAN,
Founder and Vice-President.

The Inland Waterways Assn.
11, Gower Street, London,
W.C.1.
15th February, 1960

[Mr. Aickman is entitled to his opinion and we to ours on the question of whether views expressed during this debate were representative of public opinion or whether, on the contrary, the members present were unduly influenced by a document which had been widely circulated. Several speakers admitted that they were " using the same brief " see, for example, columns 1555, 1563, 1565 and 1569 in " Hansard "—December 4th 1959; the last reference relates to the speech by Mr. Geoffrey Wilson,—a speech which warrants reading in full, noting especially that he does not believe that revenue from water supply, pleasure boats and fishing will suffice to pay for Class B canals, let alone for Class C. Ed.]

To The Editor of the Dock and Harbour Authority

Sir,

Recent Progress of British Waterways

Your Editorial Comment on Inland Waterways is welcome, but there is an implication that the considerable achievements of the present management are not fully recognised.

Despite allegations to the contrary, during the last few years considerable progress has been made in the improvement of the waterways of all classes and there has been an appreciable increase in productivity. An examination of the last Annual Report of the British Transport Commission, and of the details issued by British Waterways listing the improvement works completed or in hand, will show that the programme is not confined solely to the Class A waterways. There is ample evidence that Class B waterways have also been improved where justified by traffic requirements and even in the case of the Class C canals expenditure has risen. For instance, maintenance expenditure in 1958 increased over 1954 by 51% on Class B and by 22% on Class C. The work included such items as maintenance of reservoirs, repair and maintenance of locks, extensive dredging and clearing of feeders.

As far as the development plan is concerned, this is now approximately 40% complete. Two new locks have been opened —that at Enfield which allows 130 tons craft to proceed to the important industrial area at Brimsdown, and that at Long Sandall which opens up the Doncaster area to the craft using the lower part of the Sheffield and South Yorkshire Navigation.

Work on the Tottenham Lock and on the Lee Navigation is well in hand, and a tender has been accepted for the Thames Lock at Brentford which will facilitate access to the Grand Union system. The plans for the new and larger lock at Gloucester have been prepared and work is expected to commence towards the end of the present year. Other works of improvement are being steadily pursued and it is anticipated that unless something unforeseen happens, the plan will be virtually complete by the end of 1962.

With regard to the specious contention that the entire inland waterway system could be rehabilitated and operated commercially at a profit, it is unfortunately easy to prove from the data available that long distance carrying of general merchandise on a narrow canal often cannot pay, even if it is toll free. This fact was recognised by the Bowes Committee in paragraph 95 of their Report.

Finally, there is the suggested " compromise " proposal, that most of the Class B and all the Class C waterways should be controlled by a new " Conservancy." It is difficult to see how this is a compromise ; there seems little merit in dividing the control of the country's waterways; considerable expenditure of public funds would be needed if these Class C canals are to enjoy major renovation and the facts do not support the contention that revenues from pleasure boats and fishing would suffice.

These renovations could, of course, be carried out as part of a Government amenities programme; claims for such expenditure, however, would inevitably be considered along with a host of other claims from other sectional interests. In any case, is there any need to set up a new body in order to implement such a decision ?

London, W.1.
28th February, 1960.

Yours truly,
UNBIASED.

To The Editor of The Dock & Harbour Authority

Sir,

Administration and Documentation

Are we not in danger or putting the cart before the horse? A rational system of working will produce its own economies in paper work and the problem should be examined in that order.

Everyone who is familiar with the general scope of terminal working will recognise that congestion of paper work is in what may be called the transit area, on the wharf and in the shed, where there is the greatest concentration of traffic to be checked, adjusted for claims, accounted for and billed, in the shortest possible time, by a single central organisation. All the processes are simple, or would be if they could be performed deliberately, without harassing distraction; as it is, the administration is often almost submerged by the sheer weight of the thousands of individual transactions it is obliged to execute. The obvious solution is to devise some method of aggregating individual accounts, a policy which is followed in many large undertakings with which we, in the United Kingdom, are familiar. Analogies are numerous : in Britain the Company is the collector of the shareholder's tax on distributed profits; national insurance contributions are collected by the *employer*; purchase tax is levied on the *wholesale* price of goods. Individual accounting and enforcement in widespread activities of this kind would become impossibly unwieldy but, as it is, the transactions can be carried out simply without serious imposition on either party. Is it so entirely impractical to suggest that the port industry might follow a similar line of thinking?

To do so involves a complete breakaway from hitherto stereotyped arguments. The concept of the " ship's rail " as the dividing line of responsibility in *all* facets of working is a case in point. In this day and age it should be no more than an abstraction yet, apparently, it is still substantial enough to cast a shadow over the entire field of working, as recent correspondence in your columns has again revealed. Surely the practical boundary of responsibility, consistent with the law, ought to be at that point where the carrier (or his agent) or the consignee can begin to act upon the cargo—a point which is not fixed and unalterable but which can be varied with any reasonable invitation given to the cargo owner. The implications of this doctrine in formulating an orderly pattern of working are immense and they deserve a thorough and purposeful study by those whose duty it is to make it—the Port Authorities.

Holloway, N.7.
10th March 1960.

Yours faithfully,
H. POOTER.

To the Editor of The Dock & Harbour Authority

Sir,

The Administration of Terminal Facilities for Overseas Trade

I have read with interest the two articles "Simplification of Shipping Documents" and "The Problem of Documentation at Ports" which appeared in your issues for December and January last. Although these two studies overlap in part, in essence they traverse different areas and their impact lies in different quarters. In substance, the first study discusses the external demands made upon the carrier for statisical detail before he is allowed to enter or clear his vessel. The second is a conspectus of documentation surrounding the cargo transfer, necessitated either by law or by the policies of prudent business administration, which it is within the competence of the port transport industry to facilitate and improve. It is with this latter aspect of "documentation" that I am concerned to write further.

Documentation, after all, merely reflects the administrative and physical processes which give rise to it. The real economies are to be found in the operations themselves many of which are redundant. In achieving these economies, the volume of documentation will assuredly be reduced, after which its format can well be standardised in a more convenient way—which brings me back to the proposition contained in the article "The Administration of Terminal Facilities for Overseas Trade" appearing in your issues for September and October last.

At ports it has long been the practice to assess certain charges against the vessel and others against the cargo. Thus, dockage charges are uniformly assessed against the vessel. Wharfage, though collected from the vessel, is added to the shipper's freight bill and is actually paid by the shipper. Wharf demurrage and storage are paid by the merchant directly.

The assignment to the vessel of all costs incurred in providing dockage, wharfage, ship's services and free time storage would be a desirable innovation. Eventually, the cost of the terminal service as well as that of the sea transport is borne by the consumer. If, therefore, the entire terminal costs were initially borne by the vessel and passed on with and in the same manner as the other transport costs, the same result would be achieved. The method by which this would be accomplished would be much simpler. Hitherto, the objection raised to this course has been that it would require a review and probable adjustment of ocean freight and would involve a change in practice which would be difficult to accomplish on a piecemeal basis. Such, however, is not the case. No appreciable disturbance of freight levels need be involved.

Division of responsibility as between shipper and carrier is of little consequence in a study of this nature. The concern is with the responsibility of each to the wharfinger. Ideally, the convention should be adopted that the vessel is responsible to the wharfinger for all usages and services from, but not including, the point of rest on outbound traffic and to, but not including, the point of rest on inbound traffic, all other wharfinger costs being assessed against the cargo. The point of rest is the location at which inbound cargo is deposited and outbound cargo is picked up by the representatives of the steamship company. Further, since a vessel cannot be loaded or unloaded without bringing cargo to or removing it from the point at which the sling is applied or released, a suitable dock space must be included.

A port with which the writer was long connected put forward in recent years a proposal for simplifying operating procedure in this manner. The tariff structure was remodelled to provide for an import charge for the removal of inward cargo from the ship's side to the point of rest, or place of storage pending delivery, and for a corresponding export charge for removing cargo from the point of rest to the ship's side for shipment. Where these charges are assessed against cargo, a ship discharging or loading, say, 3,000 to 4,000 tons of cargo may involve 250 to 350 separate accounts being made up and forwarded to the respective importers or exporters. If, on the other hand, a proposal had been accepted that the charges should be transferred en bloc to the vessel after having made a suitable adjustment in the wharfinger toll, all these accounts would have been embraced by one single entry for the stevedored tonnage over the wharf included in the Captains' and Owners' Bill.

Further, consignees would not be troubled by the need for checking delivery documents against the ship's manifest for computation of charges and they would only need to concern themselves with storage charges after the free period. It was considered that apart from the immense saving of paper, clerical time and labour it would expedite delivery and shipment, and encourage a more uniform throughput of cargo with consequent benefit to the ship in quicker turnround. It was also eliminate all the relevant bookkeeping and accounting carried out by the merchants and the Port Authority.

The proposal was not accepted by the shipping lines and conferences using the port. They argued that the proposals would, in effect, transfer the cost of shore handling from merchants to carriers. The objection may perhaps have derived from a mistaken impression that the Port Authority was paying more regard to administration convenience than to a "correct" allocation of general responsibility as between carriers and merchants, who must always be jointly consulted in the working of a port.

It was further contended that all modern sea-carriage legislation is based upon the Hague Rules which state in Article 1 (e) "'Carriage of goods' covers the period from the time when the goods are loaded on to the time when they are discharged from the ship." The obligation, therefore, **in the absence of any provision to the contrary,** is to take and deliver the goods at the ship's rail which fixes the limits of the carrier's area of performance at the irreducible minimum. Frequently, however, this arrangement is varied by agreement; sometimes the whole operation of loading or discharging is undertaken by the shipowner and sometimes by the shipper or consignee, their responsibilities being apportioned in various ways. Since the carrier's obligation by agreement can be extended beyond the minimum requirement, the language of Rule 2 Article 3 merely emphasises that the whole obligation undertaken shall be performed properly and carefully.

I am firmly of the opinion that the saving of time, clerical effort, accounting and labour with consequent improved turnround which would follow from a general acceptance of the practice outlined above throughout the ports of the world would be of the greatest possible benefit to the shipping industry and to the public which it serves.

1-5 Broad Street Place, London, E.C.2.
23rd February 1960.

Yours faithfully,
W. H. LAIT.

Improved Navigational Aids for East Pakistan

An improved system of buoys, lights, marks and other modern navigational aids is to be installed in the network of channels about the lower reaches and delta of the Ganges River. These waterways carry about ninety per cent of East Pakistan's freight traffic and feed the seaports of Chittagong and Chalna Anchorage. The East Pakistan Inland Water Transport Authority will be assisted financially by means of a loan of $1,750,000 from the U.S. Development Loan Fund which will be used to meet the foreign exchange costs. At present the shifting channels are inadequately marked and cause delays which increase the cost of transportation. The proposed improvements will enable craft to move safely by day and night throughout the year, thus expediting the turn-round of shipping.

Offshore Oil Terminal of New Design

By ROLAND J. ROBERT, President
Offshore Oil Terminal Co. Inc., New York

A product of a revolutionary new design, this offshore terminal will alleviate many former problems concerned with the handling of oil tankers and their cargoes. It permits location of the offshore oil terminal in deep water away from populated areas, reduces the fire hazard, opens congested harbour lanes which will facilitate handling and avoid waiting for tides, and abolishes the cost of construction and maintenance of dock areas. It also eliminates the cost of dredging channels to suit the increasing size of tankers.

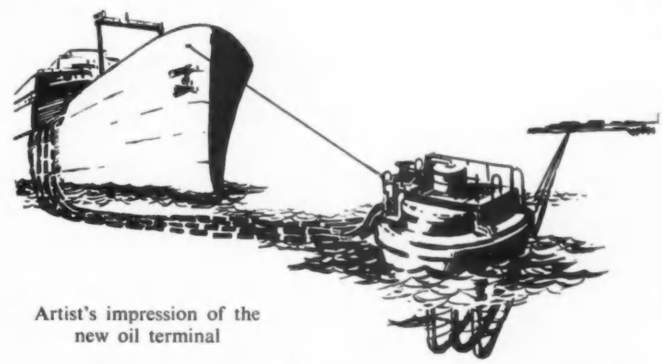
The heart of the offshore terminal is the revolving platform to which the tanker moors. Floating hose lines for cargo, bunker oil, and fresh water are attached to platform pipelines connected to the master swivel at the centre of the terminal. This exclusive design permits ship and hose lines to swing together a full 360 degrees with the wind, tide, or current. The ability to rotate the full 360 degrees permits mooring in all types of conditions and weather at any time.

The terminal may be located in deep water which permits even the largest tankers to be moored without the use of tugs or pilots, thereby saving many hours of waiting.

The standard terminal is 40-ft. in diameter and 12-ft. in depth. It is rigidly constructed of ½-in. steel plate to withstand the severest weather conditions and to accommodate any size ship, including the largest tankers now in service. This terminal has a track around its upper perimeter for the revolving platform; three or more chains are attached to heavy anchors; submarine hose lines connect the terminal to the pipe lines.

The revolving platform carries the pipe lines from the swivel to the hook-up area. The framework, around the terminal centre, supports the swivel mechanism which eliminates any possible strain on pipe couplings. The platform is revolved by the ship's hawser as the ship swings around the terminal. For a large tanker, two main mooring shoes are provided, plus two auxiliary mooring shoes. The entire mooring system is designed to withstand the severest weather conditions with a minimum strain strength of approximately 125 tons.

The hose lines are a floating type which permits them to be towed alongside the ship by a motor launch and then to be picked up by the ship's boom and connected to the deck manifolds. They consist of two 12-in. cargo lines, one 6-in. bunker oil line, and one 4-in. fresh water line, and are buoyed at intervals along their lengths to prevent damage and facilitate pickup. All lines are approximately 350-ft. in length, depending upon tanker size and location of ship's manifold. The hose lines to and from



Artist's impression of the new oil terminal

the terminal are two 12-in. I.D. Hewitt-Robins Monarch Oil Suction and Discharge Hose Lines for tanker to terminal connections, and two 16-in. I.D. Hewitt-Robins Monarch Sea Loading Hose Lines for terminal to shore connections. The lengths of the 16-in. I.D. Hoses are dependent on depth of water at terminal site. For bunkering operations, a 6-in. line is used for refuelling while cargo is being discharged and a 4-in. line is used to replenish the tanker's fresh water supply.

Unlike a permanent dock, this terminal may be submerged and raised easily in case of air attack or heavy ship traffic.

Legislation in the Port Industry

Legal Requirements for Building or Extension Works

By LAURENCE WEBLEY, LL.B.

In considering the legal rules which bear upon the port industry it seems logical to begin with those which govern the building and the extension of a port; especially as much work of this kind is being carried out in the United Kingdom at this time. These rules are somewhat elaborate for, as an old legal work puts it, "port is a gate of the kingdom and for the benefit of the kingdom".

The authority of a special Act of Parliament is therefore needed for the construction of a harbour, dock or even a pier or wharf, if it may obstruct navigation or if the promoters wish to levy tolls or rates. But if the cost of the works is less than £100,000 they may be carried out under the authority of an Order for which it is necessary to approach the Ministry of Transport and Civil Aviation.

At this point some legal definitions may usefully be noticed. The term "harbour authority" is defined by the Merchant Shipping Act 1894 as including any person, corporation, or unincorporated body who are proprietors of or have the duty or power of constructing, improving, managing, regulating, maintaining or lighting a harbour.

The term "owner of a dock", for the purpose of limiting liability under the Merchant Shipping (Liability of Shipowners and Others) Act 1900, includes any person or authority having the control or management of any dock, including wet docks and basins, tidal docks and basins, locks, cuts, entrances, dry docks, graving docks, gridirons, slips, quays, wharves, piers, stages, landing places and jetties.

The procedure for obtaining an Order from the Ministry of Transport and Civil Aviation for the construction or extension of dock and harbour works may be considered first. Such Orders are made under the General Pier and Harbour Act 1861 and are now subject to special Parliamentary procedure. This means that the Order must be laid before Parliament and petitions against it may be lodged within 14 days. If there are, in fact, no objections the Order comes into operation at the end of that time.

Before the application for the Order is lodged a notice of intention to make the application must be published in the previous October or November at least once in each of two consecutive weeks in a local newspaper and in the London Gazette. The notice must contain information on a number of specified matters and include a general description of the proposed works. Copies of the notice as published must be lodged with the Ministry of Transport and Civil Aviation, the clerk of the appropriate council and the custom house of the port concerned.

The next step is for the persons or the organisation asking for the Order to deposit a signed memorial at the Ministry, bearing the same heading as the published notice, praying for the Order to be made. This memorial must be accompanied by a printed draft of the Order the applicants are proposing, together with an estimate of the cost of the works signed by the person

who has prepared it. Printed copies of the draft must also be sent to the Custom House in London and at the port concerned, the Solicitor to the G.P.O. and, in the case of tidal water locations, the Mercantile Marine Department of the Board of Trade and the Civil Engineer in Chief of the Admiralty.

The foregoing procedure is subject to certain modifications, under the Fishery Harbours Act 1915, in respect of small harbours mainly used by the fishing industry. Moreover, in certain circumstances the power to make the Order is restricted. In particular such Orders cannot extend to the Port of London, Liverpool, Glasgow, Sunderland, Hull and Newcastle and certain limits of the rivers on which they are situated; orders are made subject to existing rights and privileges.

The Order, when issued, must state who the undertakers are and it may deal, among other matters, with the levying of rates, the leasing of land and borrowing powers.

A copy of the Order must be deposited with the clerk of the appropriate council and notice that this has been done advertised in a local newspaper. Working drawings, which must be adhered to, are required to be submitted to the Ministry for approval before the works are begun. Such works must be completed within 5 years of the confirmation of the Order. The Ministry may conduct surveys of the works at the undertakers' expense. During construction of the works navigation lights for shipping must be provided as required by the Board of Trade.

The harbour authority of a public harbour may borrow from the Public Works Loan Commissioners for the purpose of maintaining, constructing, improving or lighting such a harbour. They may also do so for any other shipping purposes, i.e. anything conducing to the safety or convenience of ships and the shipping and unshipping of goods. The consent of the Minister of Transport and Civil Aviation is required.

Finally, it is worth noting that under the Public Works Loans Act 1882 a local authority may give financial assistance to any public body authorised to raise a loan for dock and harbour works. A special resolution of the council concerned is necessary and the Minister of Housing and Local Government may prohibit such a loan if he thinks it might affect the provision of drainage and water supplies for the district concerned.

Procedure by way of a special Act of Parliament is elaborate and costly and involves many difficult requirements, not the least being the obligation to comply with Standing Orders of Parliament. Such private Acts usually incorporate, either in whole or in part, the Harbours, Docks and Piers Clauses Act of 1847. The proposals must be publicly advertised and the bill may, of course, be opposed in the course of it's passage through Parliament. Plans of the works must be deposited in accordance with the Standing Orders. Any errors may be corrected, after notice to the persons affected, under the certificate of two justices of the peace. All relevant documents, original plans and plans of alterations to the original plans must also be deposited with the clerk of the appropriate council. If the works are on the seashore, or between high and low water mark, the consent of the Commissioners of Crown Lands and the Board of Trade, both for the original works according to plans approved by these departments or for any alterations or deviations, is also necessary.

A harbour authority which neglects to obtain these consents before carrying out the works may be forced by the Board of Trade to remove them and restore the land to its former condition. If the works are on a navigable river for which there is a conservancy authority the consent of that authority is also needed.

After these requirements have been carried out the works may begin. They must be done without substantial deviation not more than 10 yards, or the specified figure laid down, from the line shown on the plans.

Construction or extension of docks and harbours, of course, almost invariably involves the purchase of land. Compulsory purchase may be authorised and the harbour authority has, in addition, generally speaking, power to purchase land by agreement for any purpose connected with the harbour or docks as specified. The purposes may include the making of yards, wharves, roads and places for goods handling and the erection of dock and harbour buildings.

The harbour authority may build any warehouses or other buildings and erect cranes and other handling, weighing or measuring machinery as it considers necessary. They are bound to provide customs buildings and sheds if required to do so by the Commissioners of Customs and Excise. Instead of working the port themselves the authority may lease it for periods of up to three years.

Major Improvements at Grangemouth Docks

A major scheme, which has been approved by the British Transport Commission, for improvements at Grange Dock, Grangemouth, at an estimated cost of £1,700,000, is soon to be commenced by British Transport Docks.

Grange Dock, constructed in 1906, has a water area of 30 acres, and is the largest of the four docks at the port. It is connected with the River Forth by a water channel and an entrance lock, 626-ft. in length and 80-ft. in width, through which vessels drawing up to 25½-ft. are able to enter and leave on all tides. Within the last year of two, considerable improvements have been effected at this dock. The North Quay, 1,900-ft. in length, has been repaved in concrete, twelve new 6/3-ton electric cranes have replaced outmoded hydraulic appliances and a new transit shed, 400-ft. in length and 60-ft. in width, was recently opened. On the East Quay, 700-ft. long, which serves mainly for the discharging of bulk dry cargoes, three new 10-ton electric grab cranes are in service, a fourth is on order and the quay is being re-surfaced in concrete.

The present scheme, which will complete the modernisation of Grange Dock, is intended to meet the growing requirements of shipping and commerce and particularly of the ocean trades which have been steadily developing for several years. The three remaining quays now to be treated are the South Quay, and the north and south sides of The Tongue, a projection 250-ft. in width and 1,200-ft. in length at the western end of the dock.

On the Tongue two existing transit sheds will be supplemented by two new single-storey sheds, 400 and 500-ft. in length respectively, and 60-ft. wide. Fourteen new level-luffing electric cranes with a radius of 65-ft., will be provided so that each of the quays will be equipped with six 6/3-ton and one 10/3-ton cranes. The crane tracks will be renewed and strengthened to carry the modern units, the railway lay-out modernised and the quay resurfaced in concrete.

The South Quay is now used partly for the loading of coal and partly for general cargo purposes. The severe reduction in coal shipments has made it possible to remove the four coal hoists and to concentrate the remaining traffic in another dock at the port. The section of the quay available for general cargo will be extended from 1,200 to 1,800-ft. and on this length, crane and railway tracks will be renewed, the quay surface re-paved in concrete and eight new level-luffing electric cranes provided, each with an out-reach of 65-ft.—four of 6/3-ton for general purposes, and four of 7½/4-tons capable of dealing with general cargoes or for discharging bulk dry cargoes by grab. In addition, two electric cranes of 3-tons capacity will be transferred from another part of the dock.

Other improvements include widening of roads, modernisation of lighting, better staff accommodation and the grounding of high voltage electric cables.

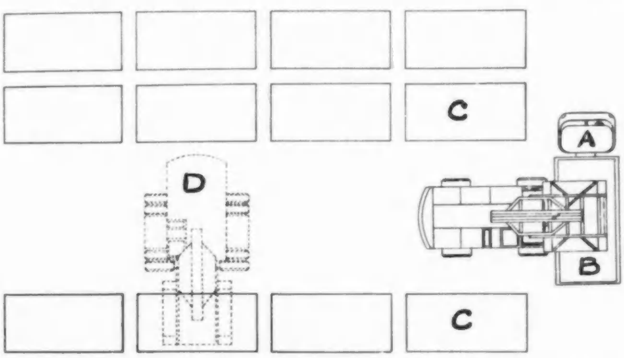
It is hoped to complete the whole scheme within two years.

Manufacturers' Announcements

New Crane for Container Handling

Efficient transport has been one of the key factors in the development of industry in Northern Ireland. The important consideration has been and always will be speed, for the raw materials and the finished products must be moved rapidly in both directions between Ireland and the United Kingdom.

One of the answers to this problem was found to be Anglo-Continental Container Services Ltd. who use four ships, some with a capacity of 38 containers. High speed, fixed handling equipment at the ports load and unload the vessels to meet time schedules imposed by tidal and other maritime considerations. To avoid congestion at the quayside mobile handling equipment had to be found which would move the containers swiftly and without damage from the quay to a container park, where the lorries which carry them are loaded and unloaded. The equipment also had to work in narrow aisles so that the full capacity of the park was used. What was needed was a piece of equipment which could work in a narrow aisle, could slew through 360°, handle containers 20-ft. long and weighing 12½ tons, hold a load firmly so it did not swing, travel and manœuvre at a reasonable speed when fully loaded, keep the container almost vertical and, at the same time, lift the load clear of other containers and transport vehicles.



Plan of a container park. The procedure is for the crane to lift the container (B) clear of the lorry or semi-trailer (A) and other parked containers (C), slew through 180° and travel to the desired spot in the aisle (D) and set down its load.

The answer was a specially designed Coles " Emperor " crane with a unique lifting gear. Instead of a normal strut type jib this crane, which is manufactured by Steels Engineering Products Ltd., Sunderland, is fitted with a special lifting mast made in the shape of a " T " or " hammer-head " ; and hinged at its lower end in support brackets at the front of the superstructure. A fabricated steel container carriage projects horizontally from the mast and is raised by means of the hoist rope which passes over pulleys on the cross piece of the " T " shaped mast and is attached centrally to the carriage or frame. Four steel rollers on the carriage run in the main vertical channel of the mast which acts as a restraining guide-way and permits a smooth hoisting and lowering action. Tilting the mast a few degrees so that the load rests against a pad has eliminated swinging and prevents damage to the container.

A feature which allows the crane to work in a narrow aisle is its short tail radius and ability of the tail to pass over the empty trailer when slewing. The result is valuable saving in aisle width and it also means that the crane can slew, before the trailer is driven away.

The crane is powered by diesel-electric transmission which supplies current to the separate motors of the hoist, derrick, slew and travel units. Maximum lifting capacity, which is based on two-thirds of the tipping load, is 12½ tons at a radius of 11-ft. 3-in. at which the lifting mast is in the vertical position required for normal operation.

The enclosed driver's cab is at the front of the revolving superstructure and gives an unrestricted view of the working area.

The chassis is specially designed for crane duties and travelling is powered by a 34 h.p. electric motor; 14.00 x 20 pneumatic tyres are fitted to pressed steel discs with twins at both front and rear.

To ensure safe operation several devices are incorporated in the design. An automatic safe load indicator weighs the load and gives the operator audible and visual warning signals when attempts are made to lift an unsafe load and halts the motion if the warnings are ignored. Electro-mechanical brakes fitted to the hoist, derrick and slew units are automatically applied if there is a break in the current, either accidental or intentional ; automatically self-resetting limit switches prevent hoisting and tilting beyond limit. Foot operated air brakes act on all wheels and for parking a mechanical hand brake is used.

Container handling crane seen slewing before placing its load onto a semi-trailer.

Radio-controlled Tugs on the Thames

One of the largest and oldest tug and lighterage companies operating on the River Thames, the Thames Steam Tug and Lighterage Co. Ltd., who became a limited company more than 100 years ago, have found that by using two-way short-wave radio to control their 14 tugs and launches for the past four years, considerable saving has been effected in time and money.

From a broadcasting station at their offices at the Minories, London, the boats, which operate from as far up-stream as Brentford down to Tilbury, Shellhaven and Thameshaven, are given instructions by an employee who has a wide experience of the river's tides and the work of the company, and the tugs themselves are able to report back.

All of the boats have Pye radio equipment, which includes a loudspeaker and telephone-type speaking apparatus fitted on the bridge. On the smaller launches, which work mostly in London docks and the River Lea, the radios are operated from the batteries used to start the diesel engines. The larger tugs of up to

400 h.p., which are capable of towing 6 barges against the tide, have two sets of Exide heavy duty batteries, type 6-KHV11R, to power the radio equipment. Two of these batteries, which have a capacity of 67 Ah at the 10-hour rate, are used in series to provide the 24 volts required, and they are recharged by a marine-type charging unit operated by the generating equipment working off the diesel engine.

Rubber Hose and Fenders

Dredge, drain and reclaim are household words in the Netherlands and it is not surprising, therefore, that as long as 30 years ago the Vredestein Rubber Works, Holland incorporated in their production programme a special line of dredging sleeves for use in both suction and discharge lines. The company have made a thorough study of this invaluable item of dredging equipment and the sleeves are manufactured to a high standard of quality, which meets the most exacting requirements.

The correct proportion of rubber, fabric and steel renders the dredging sleeve a properly balanced product, which does much to ensure uninterrupted execution of the project. These sleeves are used by all the leading dredging companies in the Netherlands and in many other countries throughout the world. They can be supplied in any current diameter and length. In addition, the company manufacture suction sleeves, discharge sleeves and couplings.

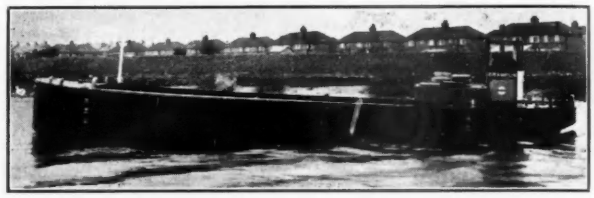
Cutter suction dredger "Ammerstol", with floating pipeline, seen at work on one of the projects of the Delta Scheme in south-west Holland.

Dock and quay fenders and wale fenders for the protection of ships are also produced. These rubber fenders are claimed to have high elasticity, great energy absorption and their resistance to weather and seawater reduces maintenance costs.

Mud Hopper Boats for British Waterways

Three all-welded diesel powered mud hopper boats are being built for the North Eastern Division of the British Transport Waterways by J. S. Watson (Gainsborough) Ltd. These barges are each 60-ft. $2\frac{1}{4}$-in. long by 14-ft. wide by 5-ft. deep and are powered by Lister Blackstone HA2MGR air cooled diesel engines, which are controlled from the wheelhouse. There is a cabin forward for day accommodation and the top half of the wheelhouse hinges down for passing uder canal bridges.

The hold amidships has a watertight ceiling of $\frac{3}{8}$-in. thick steel plate welded direct to the tops of the floors. Spirket plates are fitted between the ceiling and the side plating at an angle of 45°. The installation is single screw with the diesel engine with 2.1 reverse/reduction gear. The cooling air from the engine is trunked upwards to the atmosphere through the casing. A ventilation skylight in a portable bolted plate is fitted directly above the engine so that the engine may be removed in one piece if required. A main fuel tank of 100 gallons capacity is fitted in the engine room together with a 15 gallon service tank. The side and bottom plating is 5/16-in. thick except forward where it is increased to $\frac{3}{8}$-in. thickness, the additional thickness being necessary because the boats are liable to suffer damage due to contact with locks and walls. Five 2-in. by $\frac{3}{4}$-in. convex rubbing bands are fitted forward to give added protection, and three are continued aft.



Mud Hopper Boat, "Grampus".

The boats are ballasted aft so that the propeller is always adequately immersed and to ensure that they will manoeuvre at all times. The first two barges were delivered in January 1960 and the third will be delivered in May 1960.

New Echo-Sounder for Tanker Fleet

A new type of echo-sounder is being fitted to vessels of the Shell tanker fleet which will measure shallow clearances of water beneath the keel to within two feet. Kelvin and Hughes Ltd., in conjunction with Shell Tankers Ltd., have developed a model which is being fitted to new 18,000 d.w.t. tankers and the Marconi Marine Company Ltd., have designed a comparable unit, one of which has been fitted to a 32,000 d.w.t. tanker.

The question of under-keel clearance assumes a growing importance as larger vessels come into service, whether in open water conditions or in restricted waters such as canals. Precise measurement of this clearance may enable ships to cross large expanses of the world's oceans where the water is comparatively shallow and where otherwise long and costly deviations might be necessary. In river entrances, channels and canals, accuracy in the measurement of shallow waters might mean that deeper draft vessels could use them and larger cargoes could be carried in consequence.

The ability of tankers to take accurate soundings in shallow waters is also of great assistance to harbour masters and dock authorities concerned with dredging and siting of off-shore mooring stations.